SECTION 1.0

SITE INFORMATION

SASOL CHEMICALS (USA), LLC

2020 HWDIR EXEMPTION PETITION REISSUANCE REQUEST

SECTION 1.0 ADMINISTRATIVE INFORMATION

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 Administrative Information

EXECUTIVE SUMMARY

Sasol Chemicals (USA), LLC Greens Bayou Plant is located on the north bank of Greens Bayou, approximately four miles northeast of the city of Pasadena in Harris County, Texas. The plant manufactures cresylic acids and other chemicals, which are sold worldwide. Aqueous wastes are currently disposed on site by deepwell injection into the lower Frio Formation, as permitted by the Texas Commission on Environmental Quality (TCEQ) [permit Nos. WDW147 (Plant Well No. 1) and WDW319 (Plant Well No. 2)]. Currently, only Plant Well No. 2 (WDW319) is active. Plant Well No.1 (WDW147) is inactive and on standby.

Under the Hazardous Waste Disposal Injection Restrictions (HWDIR) regulations promulgated by the Environmental Protection Agency (EPA), 40 CFR §148, 53 Fed. Reg. 28117 (July 26, 1988), the continued injection of any waste identified as a "hazardous waste" under EPA's Resource Conservation and Recovery Act (RCRA) regulations would be prohibited unless the waste meets an EPA-specified treatment standard or EPA approves a petition demonstrating, to a reasonable degree of certainty, that continued waste injection will be protective of human health and the environment for as long as the waste remains hazardous. Subsection §148.20(a)(1)(i) of the regulations provides that such a demonstration may be made on the basis of a scientific analysis showing that the injected fluids will not migrate vertically upward out of the injection zone or laterally within the injection zone to a point of discharge or interface with an Underground Source of Drinking Water (USDW) within 10,000 years.

Sasol submitted a reissuance to the original exemption on October 19, 2000, requesting that the newly installed Plant Well No. 2 (WDW319), which is completed into the commingled Frio A&B and Frio C (Frio A/B/C Injection Interval), be added to the exemption. EPA determined that Sasol had successfully demonstrated that the 1994 exemption remained valid with the addition of the newly installed well, and that the new well satisfactorily demonstrated mechanical integrity. The reissuance to add Plant Well No. 2 (WDW319) to the exemption was approved effective by the EPA on December 27, 2000.

However, as a condition of approval for the reissuance, the 1994 approval for Plant Well No.1 (WDW147) was terminated. Sasol had not run an annular pressure test of radioactive traces survey within one year of submittal of the reissuance request; therefore, EPA determined that under 40 CFR §148.20 (a)(2)(iv) an approval for continued injection in Plant Well No. 1 (WDW147) could not be granted. The approval for injection into Plant Well No. 1 (WDW147) was terminated concurrent with the approval to allow injection into Plant Well No. 2 (WDW319).

In 1999, Sasol Chemicals (USA), LLC began a comprehensive reissuance (2000 HWDIR Exemption Reissuance) to allow for additional operations flexibility for its onsite injection wells. The requested modifications in the reissuance were:

- Extend the operational life of the exemption through December 31, 2020;
- Approval for injection into Plant Well No. 1 (WDW147) based upon demonstrating the well passing Mechanical Integrity Tests under monitoring conditions of the TCEQ Permit;
- Allow for cumulative monthly injection volume limit in each approved injection interval, regardless whether one or both wells were completed into that interval;
- Clarification of regulatory depth definitions, specifically the base of the Injection Zone;
- Addition of waste codes for protective purposes;
- Expansion of the concentration ranges for several of the injected constituents;
- Additional of an annual pressure survey for Plant Well No. 1 (WDW147); and
- Revision of the injection stream specific gravity to a running three-whole calendar month volume weighted specific gravity range of 1.00 to 1.20 at 20 ^{o}C. The three-whole calendar month to be calculated by multiplying each day's specific gravity value by that day's injected volume, totaling those values for the previous three-whole calendar month period, and dividing by that three-month injected volume.

As approved on June 28, 2006, the current exemption extended the life of injection operations through December 31, 2020. Also, Plant Well No. 1 (WDW147), which has been on standby and has not been used for hazardous waste injection since December 27, 2000, successfully demonstrated mechanical integrity under monitoring conditions of the TCEQ State Permit and was approved for continued injection.

In order to get a start on the 2020 HWDIR Exemption Petition Reissuance, Sasol Chemicals (USA), LLC prepared an update to the approved Geology and Hydrogeology section. The update included minor revisions to the structure and isopach maps included in the approved 2000 HWDIR Exemption Petition document. The revisions are a result of additional oil and gas exploratory wells being drilled within an approximate 10-mile radius of the facility. This section is transmitted as a "stand alone" document to EPA concurrent in June 2019. The supplement provided a direct comparison and identified changes between this 2020 HWDIR Exemption Petition Reissuance Section 2.0 Geology and Hydrogeology and the approved section.

In this submittal of the 2020 HWDIR Exemption Petition Reissuance, Sasol Chemicals (USA), LLC requests modifications to certain elements of the present Exemption Approval Conditions (referencing the June 28, 2006 approval). These requested modifications are specified below:

1) **Duration of the Exemption:** Sasol is requesting that Petition Approval Condition No. 3 be modified so as to specify and increase in the effective duration of the exception to December 31, 2050, from the current expiration on December 31, 2020. Future injection is modeled in this 2020 HWDIR Exemption Petition Reissuance Request at maximum rates in both injection intervals through year-end 2050, to support this request.

This 2020 HWDIR Exemption Petition Reissuance provides data and analysis sufficient under promulgated subsection §148.20(a)(1)(i) to demonstrate that continued injection of process wastewater, under the modeling at the Sasol Chemicals (USA), LLC Greens Bayou Plant will be protective of human health and the environment for as long as the waste remains hazardous. This 2020 HWDIR Exemption Petition Reissuance is sufficient to demonstrate to a reasonable degree of certainty that continued waste injection at this facility would be protective of human health and the environment for as long as the waste remains hazardous in accordance with the applicable

provisions of the Hazardous and Solid Waste Amendments of 1984 (HSWA). Accordingly, Sasol Chemicals (USA), LLC requests the EPA determine that continued injection of wastewater under the conditions described in this 2020 HWDIR Exemption Petition Reissuance would be protective of human health and the environment for as long as the waste remains hazardous and publish notice of its determination in the Federal Register in accordance with RCRA subsection 3004(i).

1.1 Regulatory Classification

The Sasol Chemicals (USA), LLC Greens Bayou Plant operates two Class I injection wells, Plant Well No. 1 (WDW147) and Plant Well No. 2 (WDW319). The injected waste stream is a composite of several major process streams and consists of an aqueous caustic solution with detectable quantities of organic and inorganic constituents. Prior to the promulgation of the Toxicity Characteristic (TC) rule (40 CFR 261, et. al., 55 Fed. Reg. 11798 (March 29, 1990)), the injected waste stream was regulated as a characteristic liquid hazardous waste due to corrosivity under EPA 40 CFR 261.22 (1) (Waste Code D002) and reactivity under EPA 40 CFR 261.23 (5) (Waste Code D003). These wastes, listed under EPA 40 CFR 268.12, were restricted from injection after May 8, 1992, without an approved Petition. The stream was petitioned for an exemption to the land disposal restrictions for EPA Hazardous Waste Numbers of D002 (corrosivity) and D003 (reactivity). EPA granted the exemption petition for D002 and D003 in the original exemption.

The promulgated Toxicity Characteristic rule (40 CFR 261, et. al., 55 Fed. Reg. 11798 (March 29, 1990)) created a new list of characteristic waste codes that are dependent on the concentration of organic constituents in the leachate from waste. After September 1990, the injected waste stream at the Sasol Chemicals (USA), LLC was also regulated as a characteristic liquid hazardous waste due the presence of benzene, chlorobenzene, cresol, o-cresol, m-cresol, p-cresol, and pyridine in the waste stream.

Additionally, the Sasol waste has the following potential waste codes: F039 (Acenaphthene); F039 (Acenapthlene); U012 and F039 (Aniline); F039 (Anthracene); U018 and F039 (Benz(a)-anthracene); U019, F005, and F039 (Benzene); F039 (Benzo(b)-fluoranthene); F039 (Benzo(k)-fluoranthene); F039 (Benzo(g,h,i)-perylene); U022 and F039 (Benzo(a)-pyrene); U037, F002, and F039 (Chlorobenzene); U050 and F039 (Chrysene); U052 and F039 (Cresol, o-Cresol, m-Cresol, and p-Cresol); U063 and F039 (Dibenz(a,h)anthracene); F039 (Dibenz(a,e)pyrene); U071 and F039 (m-Dichlorobenzene); U070 and F039 (o-Dichlorobenzene); U072 and F039 (p-Dichlorobenzene); U101 and F039 (2,4-Dimethylphenol); F039 (Ethyl Benzene); U120 and F039 (Fluoranthene); F039 (Fluorene); U137 and F039 (Indeno(1,2,3-c,d)pyrene); U165 and F039

(Naphthalene); F039 (Phenanthrene); U188 and F039 (phenol); F039 (Pyrene); U196, F005, and F039 (pyridine); U220, F005, and F039 (Toluene); and U239 and F039 (Xylene).

The above list of waste is included in the Land Disposal Restrictions Phase II Rule for Organic Toxicity Characteristic and Newly Lister Wastes and may be present in concentrations that exceed the Universal Treatment Standard (UTS) level in Sasol's waste water. All of the codes above were included in the December 2, 1994 HWDIR Exemption Petition approval (Appendix 1-2).

As part of the comprehensive 2000 HWDIR Exemption Petition Reissuance Request (approved June 28, 2006), Sasol Chemicals (USA), LLC requested that additional EPA Hazardous Waste Codes be added to Petition Reissuance Condition No. 5 for protective purposes. Requested were all applicable waste numbers identified and listed in 40 CFR 261 Subpart C and 40 CFR 261 Subpart D. The additional EPA hazardous waste numbers included 1) all characteristic D waste numbers (ignitability, corrosivity, reactivity, and toxicity); 2) al hazardous waste from non-specific sources (F waste numbers); 3) all hazardous wastes from specific sources (K waste numbers); and 4) all hazardous wastes from discarded commercial chemical products, off specification species, manufacturing chemical intermediates, container residues, and spill residues (P and U waste numbers)

The collective EPA Hazardous Waste Codes are tabulated below:

D Codes	D001, D002, D003, D004, D005, D006, D007, D008, D009, D010, D011, D012, D013, D014, D015, D016, D017, D018, D019, D020, D021, D022, D023, D024, D024, D026, D027, D028, D029, D030, D031, D032, D033, D034, D035, D036, D037, D038, D039, D040, D041, D042, D043
F Codes	F001, F002, F003, F004, F005, F006, F007, F008, F009, F010, F011, F012, F019, F020, F021, F022, F023, F024, F025, F026, F027, F028, F032, F034, F035, F037, F038, F039

K Codes	K001, K002, K003, K004, K005, K006, K007, K008, K009, K010, K011, K012, K013, K014, K015, K016, K017, K018, K019, K020, K021, K022, K023, K024, K025, K026, K027, K028, K029, K030, K031, K032, K033, K034, K035, K036, K037, K038, K039, K040, K041, K042, K043, K044, K045, K046, K047, K048, K049, K050, K051, K052, K061, K062, K069, K071, K073, K083, K084, K085, K086, K087, K088, K093, K094, K095, K096, K097, K098, K099, K100, K101 K102, K103, K104, K105, K106, K107, K108, K109, K110, K111, K112, K113, K114, K115, K116, K117, K118, K123, K124, K125, K126, K131, K132, K136, K141, K142, K143, K144, K145, K147, K148, K149, K150, K151, K156, K157, K158, K159, K161, K169, K170, K171, K172, K174, K175, K176, K177, K178, K181
P Codes	P001, P002, P003, P004, P005, P006, P007, P008, P009, P010, P011, P012, P013, P014, P015, P016, P017, P018, P020, P021, P022, P023, P024, P026, P027, P028, P029, P030, P031, P033, P034, P036, P037, P038, P039, P040, P041, P042, P043, P044, P045, P046, P047, P048, P049, P050, P051, P054, P056, P057, P058, P059, P060, P062, P063, P064, P065, P066, P067, P068, P069, P070, P071, P072, P073, P074, P075, P076, P077, P078, P081, P082, P084, P085, P087, P088, P089, P092, P093, P094, P095, P096, P097, P098, P099, P101, P102, P103, P104, P105, P106, P108, P109, P110, P111, P112, P113, P114, P115, P116, P118, P119, P120, P121, P122, P123, P127, P128, P185, P188, P189, P190, P191, P192, P194, P196, P197, P198, P199, P201, P202, P203, P2014, P205

U Codes	U001, U002, U003, U004, U005, U006, U007, U008, U009, U010, U011, U012, U014, U015, U016, U017, U018, U019, U020, U021, U022, U023, U024, U025, U026, U027, U028, U029, U030, U031, U032, U033, U034, U035, U036, U037, U038, U039, U041, U042, U043, U044, U045. U046, U047, U048, U049, U050, U051, U052, U053, U055, U056, U057, U058, U059, U060, U061, U062, U063, U064, U066, U067, U068, U069, U070, U071, U072, U073, U074, U075, U076, U077, U078, U079, U080, U089, U090, U091, U092, U093, U0, U1,94, U095, U096, U097, U098, U099, U101, U102, U103, U105, U106, U107, U108, U109, U110, U111, U112, U113, U114, U115, U116, U117, U118, U119, U120, U121, U122, U123, U124, U125, U126, U127, U128, U129, U130, U131, U132, U13, U134, U135, U136, U137, U138, U140, U141, U142, U143, U144, U145, U146, U147, U148, U149, U150, U151, U152, U153, U154, U155, U156, U157, U158, U159, U160, U161, U162, U163, U164, U165, U166, U167, U168, U169, U170, U171, U172, U173, U174, U176, U177, U178, U179, U180, U181, U182, U183, U184, U185, U186, U187, U188, U189, U190, U191, U192, U193, U194, U196, U197, U200, U201, U202, U203, U204, U205, U206, U207, U208, U209, U210, U211, U213, U214, U215, U216, U217, U218, U219, U220, U221, U222, U223, U225 U226, U227, U228, U234, U235, U236, U237, U238, U239, U240, U243, U244, U246, U247, U248, U249, U271, U278, U279, U280, U353, U359, U364, U367, U372, U373, U387, U389, U394, U395, U404, U409, U410, U411

Industrial waste permitted for injection at the Sasol Chemicals (USA), LLC Greens Bayou Plant consists of the following (see Appendix 1-1 and Appendix 1-3):

1. Waste streams generated from plant operations and generated from off-site operations at facilities owned by the owner/operator.

2. Waste streams generated from offsite operations at facilities not owned by the owner/operator which are compatible with permitted waste streams, injection zone and well materials.

3. Other associated wastes such as groundwater and rainfall contaminated by the above authorized wastes, spills of the above authorized wastes, and wash waters and solutions used in cleaning and servicing the waste disposal well system equipment which are compatible with the permitted waste streams, injection zone and well materials.

4. Waste generated during well construction or closure of WDW147 and WDW319, and associated facilities that are compatible with permitted wastes, injection zone, and well materials.

Copies of the original exemption approval for Plant Well No. 1 (WDW147) from December 2, 1994, most the current exemption approval from Plant Well Nos. 1 (WDW147) and 2 (WDW319) (June 28, 2006) are contained in Appendix 1-2. State operating permits (January 12, 2006) for the two injection wells are contained in Appendix 1-3.

1.2 Site Description

The Sasol Chemicals (USA), LLC Greens Bayou Plant is located on the Quaternary Coastal Plain of Southeast Texas in the Richard and Robert Vance Survey (A-76). The plant is located at 1914 Haden Road abuts the north bank of Greens Bayou, approximately 4 miles northeast of the town of Pasadena in Harris County, Texas (Figure 1-1). Topography of the general area is relatively flat with an elevation of 25 feet above sea level. Surface drainage from the plant site is towards Greens Bayou. Relative locations of the injection wells are shown in Figure 1-3.

1.2.1 General Identification Data

Applicant:	Sasol Chemicals (USA), LLC
Address:	Greens Bayou Plant 1914 Haden Road Houston, Texas 77015
Telephone:	(832) 783-6400
Authorized Agent for Petition:	Mr. Randy Shilling Senior Environmental Specialist Randy.Shilling@us.sasol.com Sasol Chemicals (USA), LLC 1914 Haden Road Houston, Texas 77015
Public Notice Agent:	Same as Authorized (Mr. Randy Shilling)
Wells for which Petition is submitted:	Plant Well No. 1 (WDW147) and Plant Well No. 2 (WDW319)

1.2.2 Adjacent Landowners and Mineral Owners

Adjacent landowners to the Sasol Chemicals (USA), LLC Greens Bayou Plant are presented and keyed to the maps shown in Appendix 1-4.

1.2.3 Minerals Rights Owners

Adjacent mineral owners under and adjacent to the Sasol Chemicals (USA), LLC Greens Bayou Plant are presented and keyed to the maps shown in Appendix 1-4.

1.2.4 Nature and Status of Well Activity

Type of operation or process: manufacturer of high purity phenolic products (phenol, cresols, xylenols, and cresylic acid), and sodium carbonate solutions, which are sold worldwide.

1.2.5 Facility Nomenclature

Facility owners and names have changed several times for the Sasol Chemicals (USA), LLC Greens Bayou Plant and several of the offset plants in the east Houston Area. In this 2020 HWDIR Exemption Petition Reissuance, the current facility name is used throughout the text. Injection wells are always specified by their Texas Commission on Environmental Quality (TCEQ) permit number in this document, since that number remains consistent. Facility name changes are listed below:

CURRENT FACILITY NAME	PREVIOUS FACILITY NAMES
Sasol Chemicals (USA), LLC Greens Bayou Plant	Merisol Merichem-Sasol USA LLC Merichem Company
Lyondell Chemical Company Channelview Plant	Lyondell Chemical Worldwide, Inc. ARCO Chemical Company Oxirane Chemical Company
Equistar Chemicals, LLC. Channelview Plant	Lyondell Petrochemical Company ARCO Chemical Company Sinclair
Arkema Crosby Plant	Atofina Chemicals, Inc Elf Atochem North America, Inc. Penwalt Corporation

1.2.6 Regulatory Intervals

Referenced regulatory interval tops and bottoms for each injection well are tabulated below. Depths are referenced to the original open-hole well log in each injection well and are measured from the drilling rig's kelly bushing elevation.

Well No.	TCEQ Permit Number	Base of Lowermost USDW (Log Depth)	Top Confining Zone (Log Depth)	Top Injection Zone (Log Depth)	Top Frio E&F Sand (Log Depth)	Base Frio E&F Sand (Log Depth)	Top Frio A/B/C Sand (Log Depth)	Base Frio A/B/C Sand (Log Depth)
1	WDW147 [1]	3,110	4,760	5,135	6,564	6,816	6,826	7,286
2	WDW319[2]	3,115	4,758	5,134	6,580	6,821	6,830	7,290

[1] Referenced to the August 27, 1978 ISF/Sonic Open hole log – Well No. 1 (WDW147)

[2] Referenced to the August 31, 2000 Induction Open hole log – Well No. 2 (WDW319)

1.3 Well Data – Plant Well No. 1 (WDW147)

1.3.1 Well Location – Plant Well No. 1 (WDW147)

Well Name/Number:	Plant Well No. 1 (WDW147)
County:	Harris
State:	Texas
Survey:	Richard & Robert Vance
Abstract:	A-76
Well Location (geographic coordinates):	Latitude 29° 45' 35" North Longitude 95° 10' 35" West
Well Location (legal description):	The well is located at a point 4,000 feet from the north line and 16,900 feet from the east line of the Richard & Robert Vance Survey (A-76), Harris County, approximately four miles north of the City of Pasadena.

1.3.2 Injection Program – Plant Well No. 1 (WDW147)

Plant Well No. 1 (WDW147) depths in this section are referenced to the kelly bushing elevation of 41.0 feet above mean sea level.

Well Completion Data

Spud Date:	August 8, 1978
Completion Date:	August 3, 1979
Total Depth Drilled (original):	7,336 feet

Elevation (MSL):	Original Kelly bushing (KB)	41.0 feet
	Original ground level (GL)	25.0 feet
	Original KB to GL	16.0 feet
Well Status:	Inactive (on Standby)	
Date well originally permitted:	June 26, 1978	
Date well originally placed into service:	August 1979	

Regulatory Intervals

Name and Depth of Confining Zone	Anahuac Formation	4,760 – 5,135 feet
Name and Depth of Injection Zone	Frio and Vicksburg Formations	5,135 – 7,410 feet
Name and Depth of Injection Intervals	Frio Formation (E&F Sand)	6,564 – 6,816 feet
Name and Depth of Injection Intervals	Frio Formation (A&B Sand)	6,826 – 6,980 feet
Name and Depth of Injection Intervals	Frio Formation (C Sand)	7,097 – 7,286 feet

* Referenced to the August 27, 1978 ISF/Sonic Open hole log

Figure 1-3 shows a schematic illustration of the regulatory intervals.

Note: Frio A&B Sand and Frio C Sand Injection Interval requested as a commingled interval

Rates of Injection and Volumes

Maximum injection rates: 750 gallons per minute (Frio E&F Sand)*
750 gallons per minute (Commingled Frio A/B/C Sand)*

** Cumulative with Plant Well No. 2 (WDW319)*

Maximum Injection Volumes: 394,200,000 gallons per year (Frio E&F Sand)*
394,200,000 gallons per year (Commingled Frio A/B/C Sand)*

* *Cumulative with Plant Well No. 2 (WDW319)*

Maximum surface injection pressure: 1,200 psig

1.4 Well Data – Plant Well No. 2 (WDW319)

1.4.1 Well Location – Plant Well No. 2 (WDW319)

Well Name/Number:	Plant Well No. 2 (WDW319)
County:	Harris
State:	Texas
Survey:	Richard & Robert Vance
Abstract:	A-76
Well Location (geographic coordinates):	Latitude 29° 45' 33.7" North Longitude 95° 10' 37.9" West
Well Location (legal description):	The well is located at a point 4,140 feet from the north line and 17,145 feet from the east line of the Richard & Robert Vance Survey (A-76), Harris County, approximately four miles north of the City of Pasadena.

1.4.2 Injection Program – Plant Well No. 2 (WDW319)

Plant Well No. 2 (WDW319) depths in this section are referenced to the kelly bushing elevation of 47.0 feet above mean sea level.

Well Completion Data

Spud Date:	August 7, 2000
Completion Date:	September 28, 2000
Total Depth Drilled (original):	7,408 feet

Elevation (MSL):	Original Kelly bushing (KB)	47.0 feet
	Original ground level (GL)	27.5 feet
	Original KB to GL	19.5 feet
Well Status:	Active	
Date well originally permitted:	July 21, 1995	
Date well originally placed into service:	December 27, 2000	

Regulatory Intervals*

Name and Depth of Confining Zone	Anahuac Formation	4,758 – 5,134 feet
Name and Depth of Injection Zone	Frio and Vicksburg Formations	5,134 – 7,410 feet
Name and Depth of Injection Intervals	Frio Formation (E&F Sand)	6,580 – 6,821 feet
Name and Depth of Injection Intervals	Frio Formation (A&B Sand)	6,830 – 6,984 feet
Name and Depth of Injection Intervals	Frio Formation (C Sand)	7,100 – 7,290 feet

* Referenced to the August 31, 2000 Induction geophysical open hole well log. Note: Frio A&B Sand and Frio C Sand Injection Interval requested as a commingled interval.

Figure 1-3 shows a schematic illustration of the regulatory intervals.

Note: Frio A&B Sand and Frio C Sand Injection Interval requested as a commingled interval

Rates of Injection and Volumes

Maximum injection rates: 750 gallons per minute (Frio E&F Sand)*
750 gallons per minute (Commingled Frio A/B/C Sand)*

** Cumulative with Plant Well No. 1 (WDW147)*

Maximum Injection Volumes: 394,200,000 gallons per year (Frio E&F Sand)*
394,200,000 gallons per year (Commingled Frio A/B/C Sand)*

* *Cumulative with Plant Well No. 1 (WDW147)*

Maximum surface injection pressure: 1,200 psig

1.5 Petition Quality Assurance/Quality Control (QA/QC)

1.5.1 Overview

The following information provides a coordinated quality assurance/quality control plan for the acquisition, compilation, interpretation, and evaluation of information required for preparation of this 2020 HWDIR Exemption Petition Reissuance concerning the Class I hazardous waste injection wells located at the Sasol Chemicals (USA), LLC Greens Bayou Plant site. Specific elements in this plan offer a "road map" procedure and guidance used for data acquisition, review and comprehensive evaluation, and utilization as technical support for the preparation of this document. As such, this plan provides a structured system that ensures that the work processes and the work products satisfy stated expectations.

Under the HWDIR regulations promulgated by the EPA, 40 Code of Federal Regulations (CFR) §148, 53 Fed. Reg. 28117 (July 26, 1988), the continued injection of any waste identified as a "hazardous waste" under the EPA's Resource Conservation and Recovery Act (RCRA) regulations are prohibited unless the waste meets an EPA-specified treatment standard or the EPA approves a petition demonstrating that, to a reasonable degree of certainty, continued waste injection will be protective of human health and the environment for as long as the waste remains hazardous. Subsection 148.20(a)(1)(i) of the regulations provides that such a demonstration may be made on the basis of a scientific analysis showing that the injected fluids will not migrate vertically upward out of the approved injection zone or laterally within the injection zone to a point of discharge or interface with a USDW within 10,000 years. Sasol Chemicals (USA), LLC Greens Bayou Plant received approval of its original exemption petition on December 2, 1994. The duration of the most recent exemption is set to expire on December 31, 2020 (as approved on June 28, 2006). Therefore, Sasol Chemicals (USA), LLC is required to prepare and submit a new demonstration for continued exemption to the prohibition on the land disposal of hazardous wastes.

This 2020 HWDIR Exemption Petition Reissuance will primarily be an integration process, using previously acquired historical and field data. These data are derived from many sources. A significant portion of the information has been previously reviewed by EPA, either in the original exemption, or as presented in several reissuances to the original approval. A major component of

the demonstration will consist of predictive modeling, from which the output will be used by EPA to make a regulatory decision. Therefore, the model must be scientifically sound, and the input and output must be defensible. Modeling at the Sasol Chemicals (USA), LLC site uses a set of models developed by E. I. du Pont de Nemours & Co. (DuPont) that are specifically focused to injection well applications. The analytical equations, model assumptions, and required input parameters are clearly defined in the documentation included with the models (see Section 3.0 Flow and Containment). Input parameter data that is appropriate for the modeling problem has been detailed and justified in this 2020 HWDIR Exemption Petition Reissuance. Output data has been presented in a manner by which EPA can render an informed decision that the site continues to show that the waste is, and will continue to be, contained within the currently defined Injection Zone and will not reach a point of interface or discharge to a USDW.

A multi-disciplinary geological and engineering team has assessed the quality of historical, literature, and other acquired data during the course of the project. This required compilation of previously performed testing and well field records, log runs, and completion information that has been used as a resource for determining the specific model input data and formation characteristics, their quality, and how it is representative of the formations present beneath the site. Specific analytical data derived from formation testing and processed logs are integrated into a subsurface geologic model and reservoir depiction of the injection and confining layers beneath the site. Corrections may have been applied to acquired logs and data, if results indicate such factors may be needed during the evaluation phase of the project. Information about the borehole, the reservoir, the overlying layers, and other factors, will determine the best course to integrate the collective information into an overall site model of the subsurface geology, the engineering practices (well operation), and the injection and containment formations. This information has been compiled for use in a site model from which long-term waste plume growth and formation pressure predictions have been made.

This plan has been developed to ensure proper data evaluation during the course of the project, so that accurate and appropriate data from the site, and other information sources, is obtained to support project-specific decisions.

1.5.2 Background

The governing regulations for the exemption petition are specified under 40 CFR §148.20 and 40 CFR §148.21. An owner/operator that has been granted an exemption may submit a petition for reissuance of the exemption to modify any conditions placed on the exemption, if the owner/operator complies with the requirements of 40 CFR §148.20(a), 40 CFR §148.20(b), and 40 CFR §148.20(c). Note that 40 CFR §148.20(c) only applies if the demonstration is based on attenuation, transformation, or immobilization of the hazardous constituents per 40 CFR §148.20(a)((1)(ii), which is not applicable to the Sasol Chemicals (USA), LLC Greens Bayou Plant site. Under 40 CFR §148.20(a), the owner/operator must submit a petition demonstrating that, to a reasonable degree of certainty, the hydrogeological and geochemical conditions are such that reliable predictions can be made that the injected fluids will not migrate within 10,000 years either vertically upward out of the injection zone or laterally within the injection zone to a point of discharge or interface with a USDW. At a minimum, vertical movement must consider pressure driven permeation during active injection, and movement due to other forces and molecular diffusion over the post-operational time-period. Horizontal movement must consider forces arising during active injection and/or withdrawal. These include the injection activity itself, and offset injection or withdrawal, regional movement of fluids within the injection reservoir, and buoyancy forces between the injected fluids and native formation brine. Additionally, the owner/operator must comply with the Area of Review requirements of 40 CFR §146.63 and 40 CFR §146.64 and submit the results of pressure and radioactive tracer tests performed within one year prior to submission of the petition reissuance.

Numerous models are available to perform flow and transport calculations on subsurface systems. They range from very simple analytic relationships to highly complex, three-dimensional models requiring extensive computing capacity. The model type selected for an application depends, to a large extent, on the objectives of the modeling task. In demonstrating compliance with the no migration standard, it is not necessary to be able to predict the exact location of the waste within the subsurface at all times. It is only necessary to forecast with confidence where the waste will not be located. This objective is somewhat less demanding and strongly favors the use of relatively simple and understandable models. There are several important advantages to this modeling methodology. Using simple models, the sensitivity of the calculated results to the input parameters

can be determined analytically or deduced from a qualitative understanding of the system behavior. These sensitivities are important in identifying key parameters influencing system response, determining primary sources of uncertainty in calculations, and establishing specific inputs, which will ensure conservative results. Another advantage of using simple models is that they can be individually structured to focus on the key physical mechanisms influencing system behavior at a particular site. The use of simple models permits evaluation of the contribution of each mechanism to the system under consideration.

In addition, simple models are understandable. The results are obtained from equations, which provide a clear-cut relationship between the physical mechanisms governing the system response. The ease of understanding these relationships provides the means for technical interaction by a diverse group of interested people. Safely predicting extremes of behavior for physical systems by using conservative assumptions and input data is commonly practiced by engineers to obtain results with a built-in safety factor. Models can be designed on the basis of assumptions concerning the physical characteristics of the system that will lead to an over-prediction of the distance of waste movement and pressure buildup in the injection zone and surrounding formations. This modeling methodology can then be used with confidence to predict reasonable limits to the horizontal and vertical movement of waste and to thereby demonstrate compliance with the no migration standard.

The models used for this 2020 HWDIR Exemption Petition Reissuance are: 1) the DuPont Basic Plume Model; 2) the DuPont Multilayer Pressure Model; 3) the DuPont Vertical Permeation Model; 4) the DuPont Molecular Diffusion Model; and 5) the DuPont 10,000-Year Waste Plume Model. These models meet the performance criteria of the defined task and are appropriate for the site-specific geologic setting. The models have been verified against appropriate analytic solutions, and the assumptions involved have been validated to site-specific conditions. Initial model verification and validation was conducted by EPA-Headquarters during model development and initial application of the models by DuPont in the 1980s. Detailed reverification and revalidation were conducted between EPA Region 6 and DuPont in 1999 and 2014. This revalidation/reverification information is contained in the five volume (12 books) DuPont Model Re-Verification/Re-Validation report retained by EPA Region 6. The reverification and revalidation were conducted because the models were ported from DuPont's CRAY C94 computer

to a new Silicon Graphics Origin 2014 system. Sample problems specified by EPA Region 6 are detailed and modeled in the 7 Books contained in Volume 5 of the DuPont Model Re-Verification/Re-Validation report.

Model descriptions are detailed below, and model validation and sensitivity to variations in modeled parameters are discussed in Section 3.0 Flow and Containment Modeling.

The DuPont Basic Plume Model

During injection, the volumetric growth of the waste plume and related displacement of the formation fluid away from the well dominates the movement of waste within injection reservoirs. Waste plume growth during injection is modeled in this demonstration using the DuPont Basic Plume Model. This model was introduced by Miller et al. (1986) (see Appendix 3-1).

The DuPont Basic Plume Model calculates the time-dependent lateral movement of waste emanating from the well(s) at an injection site. The model includes the effects of multiple well interactions but uses a single layer in its calculation of plume extent. A calculation is made for each layer into which waste is injected.

For the Sasol Chemicals (USA), LLC wells, injection has been modeled into the Frio E&F Sand, and the Commingled Frio A/B/C Sand Injection Intervals within the Injection Zone.

The DuPont Multilayer Pressure Model

Whenever waste is injected into a subsurface geologic formation, the pressure within the reservoir used for injection will increase. This pressure increase will be greatest at the well and will decrease with distance away from the site. After injection ceases, the pressure will rapidly diminish and approach its value before injection.

The DuPont Multilayer Pressure Model is used to determine the pressure distribution within the injection reservoir. Complete documentation of this model is presented in Appendix 3-2. This model is an extension of an earlier treatment presented by Miller et al. (1986) that was based on the Theis equation (Theis, 1935). The new development recognizes the multilayer nature of the subsurface and the ability of various permeable strata to communicate with one another, either by

permeation through aquicludes or by wellbores perforated into multiple horizons.

The model is calibrated through the adjustment of input parameters so that a match of the observed history of shut in and flowing bottomhole pressures at the injection well can be obtained. This ensures that the model is conservatively simulating subsurface conditions. The model discounts the ability of the aquiclude layers to compressively store fluids, which provides a conservative upper bound to the pressures within the injection reservoir.

For the Sasol Chemicals (USA), LLC wells, injection has been modeled into the Frio E&F Sand, and the Commingled Frio A/B/C Sand Injection Intervals within the Injection Zone. These intervals are contained within the Frio and Vicksburg Injection Zone

The DuPont Multilayer Vertical Permeation Model

The DuPont Multilayer Vertical Permeation Model is used to predict vertical fluid movement within the injection zone. This model is an extension of an earlier development presented by Miller et al. (1986), and it includes the effects of multilayer stratigraphy and aquiclude compressibility. Documentation of the DuPont Multilayer Vertical Permeation Model is presented in Appendix 3-3.

The DuPont Multilayer Vertical Permeation Model performs a separate calculation for each of the two key time frames for possible maximum fluid movement. The short-term submodel focuses on the injection period and includes the effects of compressive fluid storage in the aquiclude layers. The long-term submodel calculates the residual fluid movement 10,000 years into the future, based on the relaxation of pressure after injection ceases.

Waste injection elevates the pressure within the injection reservoirs both during injection and for a period of time afterward. This elevated pressure provides the driving force for the vertical movement of waste and formation fluid into the overlying aquiclude bounding the injection reservoir. While injection is occurring, fluid entering the base of the overlying aquiclude compresses some of the native brine immediately above it. This compression raises the pressure within the lower portion of the aquiclude and expands the aquiclude pores. The combined effects of native brine compression and aquiclude pore expansion provide the necessary space to store the

entering fluid. As time progresses, the portion of the aquiclude affected by brine compression and pore expansion grows. The short-term submodel calculates the vertical distance that the native fluids and injected waste will move into overlying aquicludes.

After injection has been discontinued, the pressure driving force for vertical permeation will dissipate, along with the compressive storage of fluids in the aquicludes. The rate of fluid movement into each aquiclude layer will decrease to zero, and the vertical permeation distance into each aquiclude will approach a final residual value. The long term submodel calculates this residual value of vertical fluid movement.

For the Sasol Chemicals (USA), LLC wells, permeation has been modeled into the shales overlying the Frio E&F Sand and the Commingled Frio A/B/C Sand Injection Intervals within the Injection Zone.

The DuPont Molecular Diffusion Model

The DuPont Molecular Diffusion Model used in this demonstration is documented, in detail, in Appendix 3-4. The model employs conservative assumptions concerning the boundary conditions for diffusion and the key model input parameter, the effective diffusion coefficient of prescribed contaminant species, to conservatively predict the distance for diffusion. This constitutes an upper bound to the true diffusion distance.

The model is based on the "Complementary Error Function" solution to Fick's Second Law of Diffusion (Freeze and Cherry, 1979). The model calculates the concentration profile of any prescribed contaminant species within the overlying aquiclude layer for the vertical region above the leading edge of the advancing bulk permeation. The contaminant concentration at this leading edge of bulk permeation is assumed to equal the concentration value in the waste stream at all times. This assumption is conservative, since the diffusion process itself will cause the concentration at this location to drop below the contaminant concentration value in the waste stream.

The effective diffusion coefficient for a contaminant species through the pores of the overlying aquiclude matrix is determined by first calculating the diffusivity value in free water solution, then correcting for the geometric complexities of the pore channels in the overlying aquiclude. The diffusivity in free water solution is found using well-established predictive methods documented in the open literature (Lerman, 1988; Treybal, 1955; Bird et al., 1960; De Kee and Laudie, 1973; Hayduk and Laudie, 1974) for both electrolyte (ionic) and nonelectrolyte solutions. These methods are typically accurate to +/-10 percent.

The geometric complexities of the pore channels are accounted for in the model by multiplying the diffusivity value in free water solution by a "Geometric Correction Factor" (G). The geometric correction factor for a particular porous aquiclude layer is determined by using a correlation developed in Appendix 3-4, which predicts G as a function of porosity and sediment lithology. This correlation is based on a host of literature data generated using a variety of very different experimental techniques and, moreover, is supported by theoretical evaluations of diffusion behavior in porous media. Furthermore, the correlation is very conservative in that it is designed to always overestimate the true value of the diffusion coefficient.

In addition to the margins of safety identified above, the DuPont Molecular Diffusion Model also implicitly contains other margins of safety. It discounts chemical effects such as adsorption and ion exchange of contaminant species onto the walls of the aquiclude pore channels. Although sometimes difficult to quantify, these phenomena are known to retard the movement of contaminant ions and molecules through typical aquiclude lithologies such as shales and clays (Freeze and Cherry, 1979). In addition, if an aquiclude layer is highly compacted, the diffusing ion or molecule may be too large to fit through the pore channels (Lerman, 1988; Deens, 1987). Finally, the presence of an electrical charge on the walls of the pore channels, as in the case of a shale or clay layer, will tend to prevent ionic (charged) species from entering the rock matrix. This latter effect has been identified as the mechanism for the so-called "osmosis" phenomenon (Freeze and Cherry, 1979).

For the Sasol Chemicals (USA), LLC wells, molecular diffusion has been modeled into the shales overlying the Frio E&F Sand and the Commingled Frio A/B/C Sand Injection Intervals within the Injection Zone.

The DuPont 10,000-Year Waste Plume Model

After injection operations have been discontinued, the waste plume can drift laterally at a very slow rate as a result of (a) natural background fluid movement and (b) buoyancy-driven drift. Natural background movement refers to the indigenous velocity of groundwater horizontally within a deep underground formation, driven by a very low hydraulic gradient characteristic of sedimentary basins. These velocities typically will be on the order of inches per year. Buoyancy-driven drift can occur when the waste is more or less dense than the formation fluid, and when the formation is not perfectly horizontal (*i.e.*, dipping). This results in a lateral component of gravitational force on the plume, driving it either updip or downdip. A more-dense waste will be less buoyant than the formation fluid and will tend to drift downdip, while a less-dense waste will be more buoyant and will tend to drift updip. This density-driven plume movement will occur relative to the natural background drift of the formation fluid. The waste plume will literally cut a path through the formation fluid. At the leading edge of the plume, the formation fluid will part to allow the waste plume to enter, while at the trailing edge, the formation fluid will close behind the plume. For typical values of density differences, reservoir properties, and dip angles, the density-driven drift velocity will normally be on the order of inches per year to a few feet a year.

The advective transport of the waste plume caused by natural background drift and density-driven motion will always be accompanied by hydrodynamic dispersion. Hydrodynamic dispersion is a homogenizing phenomenon caused by the complex interaction between the advective velocity field and geologic non-uniformities in the formation. It results in the development of a diffuse boundary between the waste and the formation fluid. Species concentrations will no longer be constant within the waste plume, as would be the case in the absence of dispersion but will vary instead with lateral position. The dispersive mixing process will also result in dilution of the waste plume. This will simultaneously reduce both the concentrations of the hazardous constituents in the plume and the density differences between the waste and formation fluid. Since the latter are responsible for the buoyancy-driven fluid movement, the velocity of buoyancy-driven drift will decrease as a result of hydrodynamic dispersion. Hydrodynamic dispersion will also enable contaminants to spread into the surrounding formation fluid and may expand the region in which concentrations exceed health-based or detection limits.

The DuPont 10,000-Year Waste Plume Model is used to predict the long-term lateral transport of waste after injection ceases (Appendix 3-5). This model includes the effects of natural background drift, density-driven drift, and hydrodynamic dispersion (molecular diffusion has also been considered but is virtually always negligible compared to hydrodynamic dispersion). The model calculates the relative concentration of species (*i.e.*, relative to the concentration in the injected waste) as a function of lateral position and time. The model provides a two-dimensional simulation of flow and transport within the horizontal plane of the injection formation. Hydrodynamic dispersion is described by means of a dispersion tensor, with principal components in the direction of the local horizontal velocity vector and perpendicular to the local horizontal velocity vector. The model equations are based on Darcy's law for flow through porous media (with appropriate account given to the effects of density variations), the law for overall conservation of mass, and the law for conservation of mass of individual trace species. Fluid density is assumed proportional to concentration, a close approximation for systems such as these, which typically reach thermal equilibrium with the formation rock well before 10,000 years. The model neglects chemical phenomena such as adsorption and ion exchange, which can act to retard the transport of contaminant species and reduce the extent of their lateral transport. It is, therefore, conservative in its predictions, providing an upper bound to the actual transport distances.

1.5.3 Project Task Description

The primary project deliverable is this 2020 HWDIR Exemption Petition Reissuance. This document has been prepared for Sasol Chemicals (USA), LLC for submittal to EPA Region 6. The governing regulations and requirements for the exemption petition are specified under 40 CFR §148.20 and 40 CFR §148.21. An owner/operator that has been granted an exemption, such as Sasol Chemicals (USA), LLC, may submit a petition for reissuance of the exemption. A reissuance to modify any conditions placed on the exemption can be granted, if the owner/operator complies with the requirements of 40 CFR §148.20(a), 40 CFR §148.20(b), and 40 CFR §148.20(c). Note that 40 CFR §148.20(c) only applies if the demonstration is based on attenuation, transformation, or immobilization of the hazardous constituents per 40 CFR §148.20(a)((1)(ii), which does not apply for Sasol Chemicals (USA), LLC, since Sasol Chemicals (USA), LLC made a containment of transport demonstration. The owner/operator must submit a new petition demonstrating that, to a reasonable degree of certainty, the

hydrogeological and geochemical conditions are such that reliable predictions can be made that the injected fluids will not migrate within 10,000 years either vertically upward out of the injection zone or laterally within the injection zone to a point of discharge or interface with an underground source of drinking water.

This reissuance document consists of the following sections:

Executive Summary

Section 1 – Site Information

Section 2 – Geology and Hydrogeology

Section 3 – Flow and Containment Modeling

Section 4 – Area of Review

Section 5 – Well Construction

Section 6 – Wastewater Description and Implementation and Compliance

Section 7 – Mechanical Integrity Tests

Each of these sections is described in the following subsections.

Section 1 - Executive Summary and Site Information

The Executive Summary contains an outline of the petition process and includes a narrative history of the original exemption approval, and approved reissuances. The Executive Summary outlines the scope of the requested modifications that are addressed in the scope of this 2020 HWDIR Exemption Petition Reissuance.

Section 1 includes the signed certification as per §148.22(a)(4), a master table of contents, plant administrative information, list of adjacent landowners, waste stream regulatory classification, well location(s), definitions for the regulatory intervals of concern and well

operating data. This section also includes this coordinated quality assurance/quality control plan for the acquisition, compilation, interpretation, and evaluation of information required for preparation of this 2020 HWDIR Exemption Petition Reissuance concerning the Class I hazardous waste injection wells located at Sasol Chemicals (USA), LLC Greens Bayou Plant site.

Section 2 – Geology and Hydrogeology

Regional and site-specific structure and stratigraphy of the regulatory intervals of concern (USDW, Confining Zone, Injection Zone, and Injection Intervals) are presented and detailed in this section. The updated displays included minor revisions to the structure and isopach maps included in the approved 2000 HWDIR Exemption Petition document. These changes are a result of new well information gathered from additional oil and gas exploratory wells having been drilled or made available within an approximate 10-mile radius of the facility. This section is transmitted as a "stand alone" document to EPA in concurrent in June 2019. The supplement provided a direct comparison and identified changes between this 2020 HWDIR Exemption Petition Reissuance Section 2.0 Geology and Hydrogeology and the approved geology and hydrogeology. The section displays show regional and site-specific maps and cross sections that follow sound geologic principles. Section text details the geological and hydrogeological framework for the detailed site modeling, details seismic risk and historic earthquake activity, and safe operating parameters. Presented data includes information on the injection interval sands and confining shales.

Section 3 – Flow and Containment Modeling

A historical model, through year end 2017, has been prepared to reflect the geology of the sedimentary section beneath the facility. Base modeling includes horizontal and vertical plume movement to show compliance with the no migration standard. Vertical movement considers pressure driven permeation during active injection and movement due to buoyancy forces and molecular diffusion over the post-operational time-period. Horizontal movement considers forces arising during active injection, including potential offset injection or withdrawal (sources and sinks), regional movement of fluids within the injection intervals, and buoyancy

forces between the injected fluids and native formation brine. Modeled pressurization in the Frio E&F Sand and the Commingled Frio A/B/C Sand Injection Intervals are used to define the limits of the Area of Review. Calibration over the historical period has been performed with site specific data to ensure that the model is consistent with the geological interpretation and well operating data.

Model input parameters have been evaluated and justified using site-specific or conservative regional or literature data to build the base case models. Potential offset pressure sources (offset Class I and Class II injection) have been evaluated in light of data gathered for this document. The base case pressurization models have been conservatively calibrated against the measured flowing and static well pressures, based on injection/falloff transmissibilities and well-to-well interference tests in the Frio E&F Sand and the Commingled Frio A/B/C Sand Injection Intervals to ensure conservatism. After calibration to lower-bound transmissibility values, a forward projection has been made using maximum rates in each interval for the onsite wells. This forward projection model also forms the basis for determining vertical permeation over the operational and post operational time periods. Historical injection volumes and the maximum projected rates are used for plume geometry depictions with time. Data plots of the calibration results and plots at the end of the future modeled operational period are prepared for pressurization, plume geometry, and vertical permeation.

Post-operational models all allow for a conservative range in waste stream properties and conservative background formation fluid velocities in the Frio. These models are used to predict long-term plume movement over the 10,000-year regulatory time period. A reasonable upper-bound permeability in the Frio E&F Sand and the Commingled Frio A/B/C Sand Injection Intervals are used for all long-term transport modeling. Long-term plume model runs are made to simulate the effects of regional flow and density driven drift on the injected water from the wells. Vertical Molecular Diffusion over the 10,000-year period is accounted for using an analytical model developed by DuPont.

The text of the Flow and Containment Model Section of this 2020 HWDIR Exemption Petition Reissuance contains a description of the models used for the demonstration, a discussion and justification for specific model input parameters, present model results at the end of the

projected operational period and the 10,000-year regulatory time period. Presented maps displaying the plume (operational and post-operational) are included in this section. A discussion of the parameters that significantly contribute to uncertainty is also presented, and a sensitivity analysis has been performed. Appendices contain detailed model descriptions, input parameter documentation and justification, and model input and output files for review.

Section 4 – Area of Review

The Area of Review section contains a discussion and determination of the Area of Review, based on the results of the pressurization modeling at the end of the projected injection period. A search of records for all artificial penetrations within the Area of Review has been conducted. Potentially impacted artificial penetrations are evaluated relevant to the non-endangerment standard. Additionally, artificial penetrations within the long-term waste plume track (within and outside of the Area of Review) are evaluated against the no migration standard. No corrective action is necessary.

The Area of Review search and evaluation protocol has been applied to verify that all of the appropriate well records have been obtained for wells within the Area of Review and the long-term waste plume track. The text of this section presents the employed search protocols, search results, well evaluations, and other relevant data, including any new or additional wells brought into the Area of Review since approval of the No Migration Exemption Petition.

Section 5 – Well Construction

The Well Construction section includes construction details for the wells as originally constructed and contains a summary of details from major well workovers that changed the construction of each well.

Section 6 – Wastewater Description and Implementation and Compliance

This section describes each of the waste streams currently being commingled and injected into Plant Well Nos. 1 and 2 (WDW147 and WDW319). The average injection rate of the composite stream for the two injection wells is approximately +/-400 gpm. Typical operating

range for the composite injected waste stream composition is shown in Appendix 6-1 and the most recent waste stream analysis (2017) is also contained in Appendix 6-1. Please Note: Plant Well No. 1 is currently inactive and on standby status.

Section 6.3 Implementation and Compliance describes the facility protocols for complying with Petition Approval Conditions, including the measurement of the three whole-calendar month running specific gravity of the injected waste stream. Additionally, protocols are developed for complying with approval conditions outlined in this 2020 HWDIR Exemption Petition Reissuance.

Section 7 – Mechanical Integrity Testing

The Mechanical Integrity Testing section includes the demonstration of mechanical integrity per EPA requirements per 40 CFR §148.20(a)(2)(iv).

1.5.4 Quality Objectives and Criteria

Fluid flow modeling is a well-developed science in both the petroleum and groundwater industries. A wide range of models are available to perform pressure response calculations due to withdrawal or injection. Flow and transport calculations within subsurface systems are also well developed. These types of models range from very simple analytic relationships to highly complex, three-dimensional models that require extensive computing capacity. However, in demonstrating compliance with the no migration standard, it is not necessary to be able to predict what will occur (*i.e.*, the exact location of the waste within the subsurface at all times), it is only necessary to forecast with confidence what will not occur. There are several important advantages to this modeling methodology of "bounding the problem." First, conservative modeling can form the basis of a petition demonstration. Additionally, by using simple models, the sensitivity of the calculated results to the input parameters can be determined analytically or deduced from a qualitative understanding of system behaviors. These sensitivities are important in identifying the key parameters influencing system response, determining primary sources of uncertainty in calculations, and establishing specific inputs, which will ensure conservative results. Another advantage of using simple models is that they can be individually structured to focus on the key physical mechanisms influencing system behavior at a particular site. The use of simple models

permits evaluation of the contribution of each mechanism to the system under consideration.

A comprehensive picture of the subsurface geology forms the framework of the demonstration and the basis for model development. This framework is built from interpretation of site-specific borehole geophysical logs, conventional and sidewall cores, pressure measurements, and laboratory tests. This information is used in conjunction with published literature and unpublished studies (including internal company studies) to complete the subsurface picture. The geologic model can also be reviewed against published literature and regional studies as a verification and reality check. Input parameters required by the DuPont Flow and Containment Model suite are:

- well locations;
- geologic/hydrogeologic layer thickness;
- permeability of the geologic/hydrogeologic layers;
- porosity of the geologic/hydrogeologic layers;
- compressibility of the geologic/hydrogeologic layers;
- fluid viscosity and density;
- original formation pressure and historic pressures;
- concentration reduction factor(s) of the constituents of concern;
- free water diffusion coefficient(s) of the constituents of concern;
- effective diffusion coefficient(s) of the constituents of concern;
- layer dispersion characteristics;
- formation characteristics (dip angle);
- waste disposal history (including offsite injection and/or production wells); and
- boundary conditions.

A systematic planning process has been used in the gathering of data. In general, site-specific data is used in preference to regional data, and regional data is used in preference to literature data or general engineering correlations. This process broadly defines an order to selection of data, from the site-specific to the general. However, even site-specific data must be reviewed for adequacy, as parameters that appear to be well constrained may have significant uncertainty due to temporal variability and other factors (such as how the data was gathered and analyzed). An analysis on each controlling model parameter is used to assess aspects of the demonstration that contribute significantly to uncertainty. Sensitivity of model results to variation and uncertainty in the key model parameters in each part of the demonstration is assessed and compensated by added conservatism in the applied model inputs, resulting in over-estimation of plume movement and pressurization.

Acceptance criteria are used to determine the adequacy of pre-existing and historical data that is applied to the modeling. Performance criteria are used to judge the adequacy of data acquired since approval of the original exemption petition, and subsequent modifications/reissuances. Performance criteria analysis is applied to each specific model input parameter to ensure that use of the input is justified in each of the models (note that certain input parameters that are conservative in one model may not be conservative in another model). Justification of each model input is described in detail in Section 3.0 Flow and Containment Modeling.

1.5.5 Data Generation and Acquisition

Information required for preparation of this 2020 HWDIR Exemption Petition Reissuance primarily consists of pre-existing data generated by activities that were not specifically part of this petition preparation process. These data consist of well operating data gathered at the facility and well testing data performed as required from the operating permits, regional geological studies conducted by various state (Bureau of Economic Geology, Texas Water Development Board, etc.) and federal agencies (United States Geological Survey, etc.), and data contained in previous permit applications and/or petition documents prepared for the facility or data from nearby facilities.

Although generated outside of the petition process, these data have been critically assessed, since they form the basis for model inputs and determination of compliance with the non-endangerment and no migration standards in this 2020 HWDIR Exemption Petition Reissuance. An assessment of the variability of each data point must also be considered, as it has a consequent effect on uncertainty in the demonstration.

1.5.5.1 Data Sampling Process Design

Input parameters required by the DuPont Flow and Containment Model suite are listed in Section 1.5.4. The demonstration contained in this 2020 HWDIR Exemption Petition Reissuance is based on an input for each of these parameters. Some of the parameters have been measured at the site, during well installation or during well operations and testing (pressures, porosities, etc.). Other data inputs have not been measured at the site. Therefore, they must be estimated either from nearby facilities, regional data (boundary conditions, formation dip angles, etc.), or estimated from the literature and/or scientific correlations (*i.e.*, diffusivities, rock layer compressibility and fluid compressibility, etc.).

1.5.5.2 Data Sampling Methods

Potential sources for the input parameters required by the DuPont Flow and Containment Model suite are detailed below:

Well Locations: The geographical coordinates of the injection well are specified in terms of an x,y coordinate system. Data on the location of the well are readily available from historical records and maps/survey plats of the plant vicinity. For deviated wells, the borehole location at its intersection with the injection horizon can be determined from a borehole deviation survey or other logging tool that is oriented in geographic space (for example a dip meter tool). The well location(s) are represented in the model as a map of the site and surrounding region. The uncertainty in the location of the borehole with its intersection with the injection horizon is generally small, on the order of tens of feet or less.

Geologic/Hydrogeologic Layer Thickness: The sequence and thicknesses of the geological units beneath the Sasol Chemicals (USA), LLC Greens Bayou Plant site can be determined

from open hole logs from the site wells, and from offset injection and oil and gas exploration wells. By analyzing resistivity, spontaneous potential, and porosity logs, thickness of functional layers can be assigned in the modeling. Cased hole logs, such as temperature profiles, spinner logs, and radioactive tracer logs, can be used to constrain "net" receptive interval thicknesses in the Injection Intervals.

Permeability of the Geologic/Hydrogeologic Layers: The horizontal permeabilities of the geologic/hydrogeologic layers can be determined from conventional and sidewall core samples, magnetic resonance logging tools, injectivity/falloff tests, interwell and interference tests, or may be estimated from regional geological studies if no site data exist. A large number of core sample data is desirable in order to obtain a representative range. Site-specific core data is available from the two site wells. Additional information is available from nearby injection facilities. Data constraining the permeability of the Frio E&F Sand and the Commingled Frio A/B/C Sand Injection Intervals are also available from results derived from injection/falloff tests at the site. These have been validated by comparing test results to nearby offset injection wells.

Values of vertical permeability of the overlying containment and confining layers can be determined from conventional and sidewall core samples from the nearby injection wells and reasonably conservative estimates based on general information in the literature for similar aquitard materials or from information for the same geological region.

Porosity of the Geologic/Hydrogeologic Layers: The porosity values of the geologic/ hydrogeologic layers can be determined from core samples, nuclear, sonic, and magnetic resonance logging tools, or may be estimated from regional geological studies if no site data exist. A large number of core sample data is desirable to obtain a representative range and determination on variability. Site-specific core data is available from the two site wells and nearby offset injection wells.

Compressibility of the Geologic/Hydrogeologic Layers: Compressibilities of rock strata are rarely measured for the geological layers at underground injection sites. However, information for derived rock mechanics data is available in the literature (Freeze and Cherry,

1979; Earlougher, 1977; Yale et al., 1993, etc.) for similar rock strata. Fluid compressibilities are also rarely measured at injection sites. Input values for fluid compressibilities can be reasonably estimated using information from the literature (Freeze and Cherry, 1979; Earlougher, 1977; etc.) and are fairly well constrained.

Fluid Viscosity and Density: The viscosity and density of the formation fluids can be determined from salinity values for the injection formations and formation temperatures. Site-specific formation fluid analyses from the lower Frio Injection Intervals are available from Plant Well No. 1 (WDW147) and Plant Well No. 2 (WDW319). Data is consistent with fluid sample results obtained at nearby injection facilities. Direct laboratory measurements of the viscosity and density (or specific gravity) of the formation fluid samples are also available. Appropriate corrections, using literature nomographs of viscosity as a function of temperature and salinity, and density as a function of temperature and salinity, can be made from transitioning from laboratory conditions to formation conditions at depth.

Original Formation Pressure and Historical Pressures: An initial formation pressure at a specific reference depth is used as the reference point for the operational period pressure models. Historical pressures are available from both wells. Periodic pressure measurements were obtained intermittently prior to 1989 and have been collected annually since then. These data can be verified against similar testing conducted at nearby injection facilities.

Concentration Reduction Factor(s) of the Constituents of Concern: The concentration reduction factor used in the models is calculated by dividing the published health-based standard (limit) of each constituent of interest by the concentration at the wellhead of the constituent. An appropriate source for the health-based limit used to calculate the concentration reduction factor for each constituent can be taken from the *EPA Region 6 Land Ban Health Based Guideline* (revised July 21, 2004). Wellhead concentrations of the constituents of concern are well known from analytical testing periodically conducted at the facility.

Free Water Diffusion Coefficient(s) of the Constituents of Concern: The diffusivity in free water solution can be determined using well-established predictive methods that are

documented in the open literature (Lerman, 1988; Treybal, 1955; Bird et al., 1960; De Kee and Laudie, 1973; Hayduk and Laudie, 1974) for both electrolyte (ionic) and nonelectrolyte solutions. These methods are typically accurate to +/-10 percent, which results in a +/-5 percent uncertainty in calculated transport.

Effective Diffusion Coefficient(s) of the Constituents of Concern: Geometric complexities of the pore channels are accounted for in the DuPont Molecular Diffusion Model by multiplying the diffusivity value in free water solution by a "Geometric Correction Factor" (G). The Geometric Correction Factor for a particular porous aquiclude layer is determined by using a conservative correlation developed, which predicts the Geometric Correction Factor as a function of porosity and sediment lithology (see Appendix 3-4). This correlation is based on a host of literature data generated using a variety of very different experimental techniques and, moreover, is supported by theoretical evaluations of diffusion behavior in porous media. Furthermore, the correlation is very conservative in that it is designed to always overestimate the true value of the diffusion coefficient.

Layer Dispersion Characteristics: Layer dispersion characteristics of strata are rarely measured for the geological layers at an underground injection site. Input values for layer dispersion characteristics can be reasonably bounded using information from the literature (Xu and Eckstein, 1995; etc.) for similar strata and scale of transport, and using site specific core information (see Appendix 3-1). Values for dispersion can be broadly constrained in cases where new wells (injection or oil and gas) have been drilled on or near the facility.

Formation Characteristics (dip angle): The dip of the injection intervals with respect to the horizontal can be determined from borehole geophysical logs, or may be estimated from local and regional geological studies, if no site-specific data exist. Local and regional structure maps prepared for Sasol Chemicals (USA), LLC (Section 2.0 Geology and Hydrogeology) are used to determine the variability in the rate of structuring of the geologic formations of interest over the areas of likely plume extent. Reasonable bounds can be placed on the geologic structuring and rate of dip across the plume area.

Waste Disposal History (including offsite injection and/or production wells): The history of the injection rates into each injection well is specified by records maintained at the facility in the site operating records. These data have been submitted to the applicable permitting authorities for the wells. The information can be supplied to the model on an average annual basis or, preferably, on an average monthly basis. Similar data is available for injection operations at the nearby facilities.

Boundary Conditions: In certain situations, near-field boundary conditions can be observed on injection/falloff tests and/or interference tests. However, the calculated radius of investigation for these types of tests is often effectively limited to hundreds to a few thousands of feet, increasing in proportion to the square-root of time. Beyond the radius of investigation of these types of pressure transient tests, identification and presence of flow barriers can be obtained from geological surveys of the site, including both local and regional geologic studies. Sasol Chemicals (USA), LLC has prepared a series of structure maps, isopach maps, and cross sections through the Area of Review and immediate area to help evaluate the location of potential geologic boundaries and discontinuities (Section 2.0 Geology and Hydrogeology).

Each of the model input parameters are detailed in the text of Section 3.0 - Flow and Containment Modeling. Sources of each parameter are described (site-specific measurement, indirect measurement, literature measurement, etc.) and justified in the context of the model-specific strategy.

1.5.5.3 Data Handling and Custody

The majority of the data required for this 2020 HWDIR Exemption Petition Reissuance consists of pre-existing information. These data consist of well operating data gathered at the facility and well testing reports per requirements of the operating permits, regional geological studies conducted by various state (Bureau of Economic Geology, Texas Commission on Environmental Quality, etc.) and federal agencies (United States Geological Survey, etc.), and data contained in previous permit applications and/or petition documents prepared for the facility. Historic operational data has been copied and retained during preparation of this reissuance. Published regional scientific reports and studies may be obtained directly from the relevant federal or state

agency or publishing company and will be retained in the project files. These data will be retained for the duration of the processing of the reissuance project, and for a five-year period beyond final approval of the renewal. Sasol Chemicals (USA), LLC may make arrangements for secure offsite storage of facility information and the final 2020 HWDIR Exemption Petition Reissuance.

1.5.5.4 Analytical Methods

The information required for preparation of this 2020 HWDIR Exemption Petition Reissuance primarily consists of pre-existing data, generated by activities that are not specifically part of the petition process. These data consist of well operating data gathered at the facility and well testing data per requirements of the operating permits, regional geological studies conducted by various state and federal agencies, and data contained in previous permit applications and/or petition documents prepared for the facility.

The DuPont Basic Plume Model, DuPont Multilayer Pressure Model, DuPont Vertical Permeation Model, and DuPont 10,000-Year Waste Plume Model are run on a LINUX cluster located at the Geostock Sandia, LLC office, located in Houston, Texas. The LINUX cluster is accessed by users through a secure connection from a personal computer to the LINUX cluster via WinSCP (files management) and Putty (terminal emulation) software. Model input files are created in Microsoft WordPad as ASCII files and uploaded to the LINUX cluster for execution. Once the model run computations have been completed, data output files are transferred via WinSCP file transfer from the LINUX cluster back to a personal computer for evaluation and post-processing within various commercial graphics packages.

Data plot files from the DuPont Multilayer Pressure Model (pressure with time - .pinj and .pmon files) and the DuPont Vertical Permeation Model (permeation distance with time - .upp file) are imported into Microsoft EXCEL to prepare “model-response” with time Cartesian graphs. Areal distribution of pressure at specified times, as output from the DuPont Multilayer Pressure Model (pressure contour data - .pcnt files) are exported to Microsoft EXCEL, where a “macro” is used to prepare x,y,z “comma-delimited” data files from the model output .pcnt file arrays. These data are exported as comma-delimited files and contoured using Golden Software, Inc.’s Surfer software package. The pressure contour plots can then be overlain on various basemaps that shows the local geography and surface features, so that the scale of model response can be viewed.

DuPont Basic Plume Model output data (.plt plotting files) are exported to Microsoft EXCEL, where a "macro" is used to prepare x,y "comma-delimited" post files from the model output .plt file arrays. These data are exported as comma-delimited files and posted using Golden Software, Inc.'s Surfer software package. The operational plume plots are overlain on various basemaps that shows the local geography and surface features, so that the scale of model response can be viewed.

The DuPont Molecular Diffusion Model is an analytical calculation that follows the methodology outlined in Appendix 3-4 of Section 3.0 Flow and Containment Modeling. In order to handle the repetitive calculations for a large number of constituents, a computational "model" has been set up in Microsoft EXCEL to perform the relevant calculations. Use of the Microsoft EXCEL model also ensures greater precision in determining the dimensionless vertical distance parameter using a "look up" function for the "complementary error function" (erfc), which is contained in Microsoft EXCEL, than can be derived from "eye-balling" Figure 3 in Appendix 3-4 or by extrapolating the value from a tabulation of the complementary error function available in standard mathematics or engineering text books.

DuPont 10,000-year Waste Plume Model output data (.out plotting files) are run through a FORTRAN conversion routine available on a personal computer (the routine creates a Golden Software, Inc.'s Surfer compatible gridding file (in ASCII format). This file is then contoured using Golden Software, Inc.'s Surfer contouring package. The long-term plume plots are overlain on a basemap that shows the local geography and surface features, so that the scale of model response can be viewed.

1.5.5.5 Quality Control

The information required for preparation of this 2020 HWDIR Exemption Petition Reissuance primarily consists of pre-existing data, generated by activities that were not specifically part of the petition process. These data consist of well operating data gathered at the facility and well testing data per requirements of the operating permits, regional geological studies conducted by various state (Bureau of Economic Geology, Texas Commission on Environmental Quality, etc.) and federal agencies (United States Geological Survey, etc.), and data contained in previous permit applications and/or petition documents prepared for the facility.

Where possible, original sources of data have been evaluated and assessed for this 2020 HWDIR Exemption Petition Reissuance. For each original data source, the sampling process, analytical procedure, and technique (where available) has been reviewed for adequacy and acceptance for use in this 2020 HWDIR Exemption Petition Reissuance. Standard operating procedures and protocols that were used to sample, process, analyze, and report each source of data, where available, have also been evaluated to determine the usability and uncertainty of any measurement. Where quality assurance/quality control (QA/QC) checks were performed as part of the original sampling, processing, or analysis activities, they are also reviewed against acceptance criteria.

1.5.5.6 Instrument/Equipment Testing, Inspection, and Maintenance

In modeling, the calibration process involves comparing model predictions for a set of given conditions with a reasonably similar set of real-world conditions. A common method of calibration for Class I injection wells consists of comparing simulated pressurization with time against high-resolution data obtained during static reservoir, injection/falloff transient, or interference transient testing. Reservoir characteristics of the injection intervals are determined from the ambient pressure falloff tests in the site well using transient analysis and core data. Reanalysis of previously obtained historical transient data has been made using Reservoir Description Services, Inc.'s pressure transient analysis and report software (TRANS II). TRANS II allows for the identification of flow regime, computation of the pressure derivative function, and reservoir parameter analysis (transmissibility, skin, static formation pressure, etc.) by both type-curve matching (Log-Log Plot) and superposition analysis (Semi-Log Plot). Final model calibration is verified through pressure history simulation of the measured data with the model predicted response.

In an interference test (when applicable), the flow rate is changed in one (or more) wells, and the response is observed at a second well. Simple well-to-well transient analysis of the interference response can be used in cases where the "Observation Well" has reached static conditions prior to initiating the interference test. However, transient analysis of the observed interference effects can be quite complex in cases where the Observation Well has a rate history that affects the observed pressure response (*i.e.*, provides a "background trend"). In situations where the Observation Well has been recently operating, the interference response may be partially or entirely masked by

transients generated by the Observation Well itself. In these cases, pressure history simulation can be used to model the multiple sources of the observed pressure response. Pressure history simulation is an iterative technique that involves generating the pressure response signal at the Observation Well created by the rate histories of each active well, the distance between wells, and the input reservoir and well parameters. The pressure response at the Observation Well is generated by analytically solving the diffusivity equation (line source solution) for each active offset well and adding the sum of all the responses to the Observation Well pressure simulation response. The response from each source is summed and then compared back to the actual measurement. An assessment of the "degree of fit" is made between the pressure history simulation and the actual measurements. The simulation is iteratively run, after adjusting reservoir parameters, so that the "degree of fit" is increased until a match is achieved.

The DuPont Multilayer Pressure Model can also be calibrated through longer-term pressure history matching, using monthly model predicted pressures versus historic site-specific measurements of well shut in (static pressures) and transient test calculated flowing bottomhole reservoir pressures (corrected for well skin effects). All site measurements and model predictions are referenced to a common depth, so that meaningful comparisons can be made. Calibration of the model over the longer-term historical time period, as opposed to site-specific model matching over much shorter individual transient period, as described in the previous paragraph, reduces the uncertainty in the modeling results. Because the effective radius of investigation of short-term transient tests are generally limited to hundreds to a few thousands of feet, geological nonuniformities located at the periphery, or well beyond the radius of investigation of individual transients, have negligible effect during the transient test period. However, nonuniformities that are located at a distance from the point of injection may have a significant influence on the long-term pressure buildup, as their effects are manifested over decades of historical injection.

A comparison of the model-predicted pressure buildup with time through 2017, in the Frio E&F Sand and the Commingled Frio A/B/C Sand Injection Intervals has been made with historical pressure data (both measured static bottomhole pressure and calculated flowing bottomhole pressure) from the site wells. Simulation output data (time and incremental model pressure (pounds per square inch)) will be presented as a Cartesian "x-y" graph. Overlain on the graph will be data points representing the measured well shut in (static) pressure data. A separate graph will

be made for model calculated flowing reservoir pressures with the transient test calculated flowing reservoir pressures overlain on the model data. Quality of fit for these longer term pressure history match calibrations are assessed on the degree of "over prediction" of the model pressures versus the site-specific measured shut in and calculated flowing pressures. Acceptance criterion of the "conservative overmatch" is set for when the majority of the site-specific measured shut in and calculated flowing pressures are exceeded by the model predictions. As such, this conservative model calibration of the operational pressure model has been conducted for this 2020 HWDIR Exemption Petition Reissuance. This pressure comparison to historic injection interval pressures is discussed in Section 3.0 Flow and Containment Modeling.

The remaining models used in this 2020 HWDIR Exemption Petition Reissuance (DuPont Basic Plume Model, DuPont Vertical Permeation Model, DuPont Molecular Diffusion Model; and DuPont 10,000-Year Waste Plume Model) cannot be directly calibrated against site-specific data at the Sasol Chemicals (USA), LLC site. This is a result of the lack of observable measurements or testing that could be historically or currently conducted at the site that can be directly compared back to the model predictions. The time frame of both the DuPont Molecular Diffusion Model and the DuPont 10,000-Year Waste Plume Model are of such long-term duration that observable and measurable changes at the site are not obtainable over the operational period. Although pressure driven permeation into aquitards overlying the injection interval (DuPont Vertical Permeation Model) occurs during the operational injection period of the facility, the science to directly measure and resolve in situ bulk vertical movement of injectate is currently lacking. At sites where many injection wells (or nearby oil and gas wells) have been drilled during the historical period (or multiple vertically spaced injection intervals have been used), calibration of the DuPont Basic Plume Model to injectate encounters (either during well installations or recompletions, and measured by differential temperature logging passes across shallower injection intervals) can place minimum constraints on horizontal plume movement. Conversely, waste non-encounters can be used to constrain maximum transport distances and plume geometries. For these models, a strategy of employing conservative input parameters is instead used to bound the solutions for model results.

1.5.5.7 Non-direct Measurements

Non-direct measurements consist of pre-existing data or information that will be used for this 2020 HWDIR Exemption Petition Reissuance project. However, since the non-direct measurements have been generated outside the scope of the project, the methodologies used to acquire, sample, or analyze the data cannot be specified in this plan. However, the applicability of the data to this project can be evaluated.

Because injection involves processes occurring thousands of feet below ground level, data is needed to characterize the geologic and hydrologic framework of the subsurface. However, certain characterization data only can be obtained at specific times. Examples of this type of "single opportunity" chance to obtain data are core samples or open-hole well log suites of the subsurface formations. These types of data can only usually be obtained during initial well installation (or perhaps during major well rework) activities. Since the wells of interest have already been in operation, pre-existing data, which was gathered during initial well installation, previous well testing, and other specific circumstances, must be used in this 2020 HWDIR Exemption Petition Reissuance. These data can be validated through information gathered during more recent injection well installations at nearby facilities.

Specific modeling data needs for the project and the potential sources for the non-direct measurements anticipated to be used in this 2020 HWDIR Exemption Petition Reissuance are presented in the individual document sections. Generally, these sources include published regional studies conducted by state and federal agencies or academic institutions. Non-direct measurement sources specific to the site include reports prepared by vendors and consultants or databases retained at that time by Sasol Chemicals (USA), LLC, which concern installation, completion, well testing, or daily operation of the injection well.

Once all of the available sources of a specific model input have been obtained, it is necessary to evaluate the underlying quality of each individual source of this pre-existing data. In cases where the raw data and the specific methodology, procedures, analyses, calculations, or quality checks of how the raw data was acquired is available, a quality assessment can be made as to the relevancy and reliability of the data. The overriding goal of the quality assessment is to rank each specific

data source, so that representative data, most reflective of actual in situ conditions, is favored for use in this 2020 HWDIR Exemption Petition Reissuance. Use of the most representative data reduces uncertainty in the modeling output, upon which the regulatory determination is based.

Sources of data in this 2020 HWDIR Exemption Petition Reissuance are detailed within the text of each relevant section. Where the underlying data is available, the discussion includes a description of the sampling process, analysis methodology, representativeness, and precision of each measurement. In cases where more than one source of data is available for use in this 2020 HWDIR Exemption Petition Reissuance, individual sources of data are described and evaluated. The appropriateness of why a particular data set is selected for use, over other available data, is described and justified.

1.5.6 Document Control

This 2020 HWDIR Exemption Petition Reissuance is prepared as a stand-alone document and contains the demonstration required under 40 CFR §148.20(e). This 2020 HWDIR Exemption Petition Reissuance is anticipated to consist of the following sections:

Executive Summary

Section 1 – Site Information

Section 2 – Geology and Hydrogeology

Section 3 – Flow and Containment Modeling

Section 4 – Area of Review

Section 5 – Well Construction

Section 6 – Wastewater Description and Implementation and Compliance

Section 7 – Mechanical Integrity Tests

Each section of the document has been prepared by a designated member of the technical project team, working under the direction the Technical Project Manager. Once the section is fully prepared (including tables, figures, and appendices), the working copy of the section received an initial review by the designated Technical Project Manager. Following this initial review, a second technical review has been performed by a person outside of the project team ("peer review"). Concurrent with this peer review, an administrative/editorial review of the working document was also made. Each working section received a final review by the Technical Project Manager. The working section was then assembled for review by the Sasol Chemicals (USA), LLC, or its designees. Following this review, the section was finalized and assembled for incorporation into this 2020 HWDIR Exemption Petition Reissuance.

Once the entire 2020 HWDIR Exemption Petition Reissuance document was completed, the Master Table of Contents, Master List of Figures, Master List of Tables, and Master List of Appendices were prepared and cross checked against the individual sections. The complete document has received a final proof prior to submittal to EPA Region 6. This final proof review was performed in concert with the preparation of the document "Crosswalk for UIC Land Ban Petition Review" table. This ensures that the submittal is complete, and all portions of the applicable regulations have been addressed.

1.5.6.1 Document Retention

Sasol Chemicals (USA), LLC will retain copies of this 2020 HWDIR Exemption Petition Reissuance. These will be retained for the time period through final agency action on the reissuance. Following final agency action, supporting facility information and the approved 2020 HWDIR Exemption Petition Reissuance will be retained at the site while the wells are in operation, or until a new reissuance is sought. Additionally, Geostock Sandia, LLC will retain a copy of the document and supporting files for a minimum five-year period. At the end of this five-year retention time period, Geostock Sandia, LLC may elect to make arrangements for secure offsite storage of facility information and the final 2020 HWDIR Exemption Petition Reissuance, or arrange for return of all of the information back to Sasol Chemicals (USA), LLC, or its designees, for storage.

1.5.7 Data Validation and Usability

This section describes the final project checks that have been performed to ensure usability of the data within this 2020 HWDIR Exemption Petition Reissuance and the document itself. For the Flow and Containment Modeling, these checks assure that the modeling was performed correctly, following the outline procedures contained in the user's manual for the DuPont Deepwell models (DuPont Model Re-Verification/Re-Validation report (October 1999)), and that the output data is properly presented within this 2020 HWDIR Exemption Petition Reissuance.

1.5.7.1 Data Review, Validation, and Verification

Data review consists of the in-house evaluations that were performed to ensure that data and information has been recorded, transmitted, transcribed, and processed correctly during preparation of this 2020 HWDIR Exemption Petition Reissuance. Site operating information and model input files have been cross-checked against raw data, where possible, to ensure that the values were properly used in this 2020 HWDIR Exemption Petition Reissuance and are properly input into the models. Any intermediate calculations, such as conversions used to transform raw data into model input units (*i.e.*, unit conversions), have also be reviewed and cross-checked. Calculations used in this 2020 HWDIR Exemption Petition Reissuance and spreadsheets that are used to manage data have been cross-checked with at least one representative "hand calculation' to ensure accuracy in any of the transformations performed. Where conversion or input errors were identified, the deficiencies have been corrected.

Each section of the document has been prepared by a designated member of the project team. The section author is responsible for the initial section preparation, assembly, and review. This includes both technical and administrative aspects of the section. Once the "working" section was complete, including text, tables, figures, and any supporting appendices, the formal, sequential review process for this 2020 HWDIR Exemption Petition Reissuance followed the steps shown:

Working Section

Step 1 Initial technical review of the "working section" by the Technical Project Manager

Step 2 Concurrent technical review by a person not associated with the project (peer review) and an administrative/editor review of the "working section"

Step 3 Final technical review of the "working section" by the Technical Project Manager

Step 4 Client review of the "working section" by Sasol Chemicals (USA), LLC, or its designees

Final Document

Step 5 Concurrent final technical review by the Technical Project Manager and an administrative/editor review of this 2020 HWDIR Exemption Petition Reissuance

Step 6 Administrative review of the assembled 2020 HWDIR Exemption Petition Reissuance for completeness and preparation of the "Crosswalk for UIC Land Ban Petition Review" table.

The models used for this 2020 HWDIR Exemption Petition Reissuance are: 1) the DuPont Basic Plume Model; 2) the DuPont Multilayer Pressure Model; 3) the DuPont Vertical Permeation Model; 4) the DuPont Molecular Diffusion Model; and 5) the DuPont 10,000-Year Waste Plume Model. These models meet the performance criteria of the defined task and are appropriate for the site-specific geologic setting. The models have been verified against appropriate analytic solutions, and the assumptions involved have been validated to site-specific conditions. Initial model verification and validation was conducted by EPA-Headquarters during model development and initial application by DuPont in the 1980s. Detailed reverification and revalidation was conducted by EPA Region 6 and DuPont in 1999 and 2014, which is contained in the five volume (12 total books) *DuPont Model Re-Verification/Re-Validation* report. This reverification and revalidation was conducted when the models were ported from DuPont's CRAY C94 computer to a Silicon Graphics Origin 2014 system. Solutions of the sample problems are detailed in the 7 Books contained in Volume 5 of the *DuPont Model Re-Verification/Re-Validation* report.

1.5.7.2 Validation and Verification Methods

Model output summary files have been compared to the input file data to ensure that the data was correctly read during model execution. Where input errors or spacing errors leading to incorrect data reads were identified, the deficiencies were corrected, and the affected model(s) were rerun. Model results were also reviewed with a "reality check" (*i.e.*, do the results make sense based on input data, model strategy, and model term). Model results have been compared to simple analytic relationships for pressure buildup, plume size, and distance of long-term plume movement, to ensure that the model results fall within the range of expected outcomes. If model results were found to fall significantly outside of expectations, model input and output files were carefully reviewed to determine why model results fall outside of expectations, and identified discrepancies were corrected.

Each section of the document was prepared by a designated member of the project team, who was also responsible for preliminary section review. Work progress was also periodically reviewed during the course of the project. Once the section was fully prepared (including tables, figures, and appendices), the working copy of the section received an initial review by the Technical Project Manager. Following the initial review and correction of identified deficiencies or additions to the text, a second technical review was performed by a person outside of the project team. Concurrent with this second technical review, an administrative/editorial review of the working document was also made. The working section received a final review by the Technical Project Manager prior to review by Sasol Chemicals (USA), LLC, or its designees. Following review of each section by Sasol Chemicals (USA), LLC, or its designees, each individual section was finalized and prepared for incorporation into this 2020 HWDIR Exemption Petition Reissuance.

1.5.7.3 Reconciliation with User Requirements

Adequacy in the use of existing data on this project is based on an evaluation of each source of data, how it was obtained, processed, and transformed to usable format. Where data limitations are found, re-analysis of raw data may have been required, either to confirm data results or to reduce uncertainty.

In demonstrating compliance with the non-endangerment and no migration standards, it is not necessary to be able to predict what will occur (*i.e.*, the exact location of the waste within the subsurface at all times), it is only necessary to forecast with confidence what will not occur. This type of conservative modeling can form the basis of a petition demonstration per 40 CFR §148.21(a)(6).

A discussion of the parameters that significantly contribute to uncertainty is presented in each section and, where practical, a sensitivity analysis has been performed as part of the demonstration. Additionally, by using simple models, the sensitivity of the calculated results to the input parameters can be determined analytically or deduced from a qualitative understanding of system behaviors. These sensitivities are important in identifying the key parameters influencing system response, determining primary sources of uncertainty in calculations, and establishing specific inputs, which ensure conservative results. The sensitivity analysis identifies to what effect that uncertainty contributes to model outcome. The demonstration of non-endangerment and no migration are based on defined conservative assumptions for the key model input parameters and boundary conditions, which are specifically outlined in this 2020 HWDIR Exemption Petition Reissuance.

REFERENCES

Bird, R. B., W. E. Stewart, and E. N. Lightfoot, 1960, Transport Phenomena: Wiley, New York.

Deens, W. M., 1987, Hindered transport of large molecules in liquid-filled pores, AIChE Journal, v. 33, n. 9, pp. 1409-25.

De Kee, J. H., and H. Laudie, 1973, Diffusivities of non-electrolytes in water at atmospheric pressure: Chemical Engineering, v. 80, n. 29, pp. 74-74.

Earlougher, R., C., Jr., 1977, Advances in Well Test Analysis: Society of Petroleum Engineers, Millet the Printer, Inc., Dallas, Texas, 264 p.

Freeze, R. A., and J. A. Cherry, 1979, Groundwater: Prentice-Hall, Inc., Inglewood Cliffs, New Jersey, p. 604.

Hayduk, W., and H. Laudie, 1974, Prediction of diffusion coefficients for non-electrolytes in dilute aqueous solutions: AIChE Journal, v. 20, pp. 611-15.

Lerman, A., 1988, Geochemical Processes Water and Sediment Environments: Krieger, Malabar, Florida.

Miller, C., T. A. Fisher, II, J. E. Clark, W. Porter, C. H. Hales, and J. R. Tilton, 1986, Flow and containment of injected waste: Proceedings of the International Symposium Subsurface Injection of Liquid Wastes, New Orleans, National Water Well Assc., Dublin, Ohio, pp. 520-559.

Theis, C. V., 1935, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage: Trans. Amer. Geophys. Union, v. 2, pp. 519-534.

Treybal, R. E., 1955, Mass-Transfer Operations: McGraw-Hill, New York.

Xu, M., and Eckstein, Y, 1995, Use of weighted least-squares method in evaluation of the relationship between dispersivity and field scale: Groundwater, v. 33, n. 6, pp. 905-908.

Yale, D. P., Nabor, G. W., Russell, J. A., Pham, H. D., and Yousef, M., 1993, Application of variable formation compressibility for improved reservoir analysis: Society of Petroleum Engineers, SPE Paper 26647, Houston, Texas, p. 435-450.

FIGURES

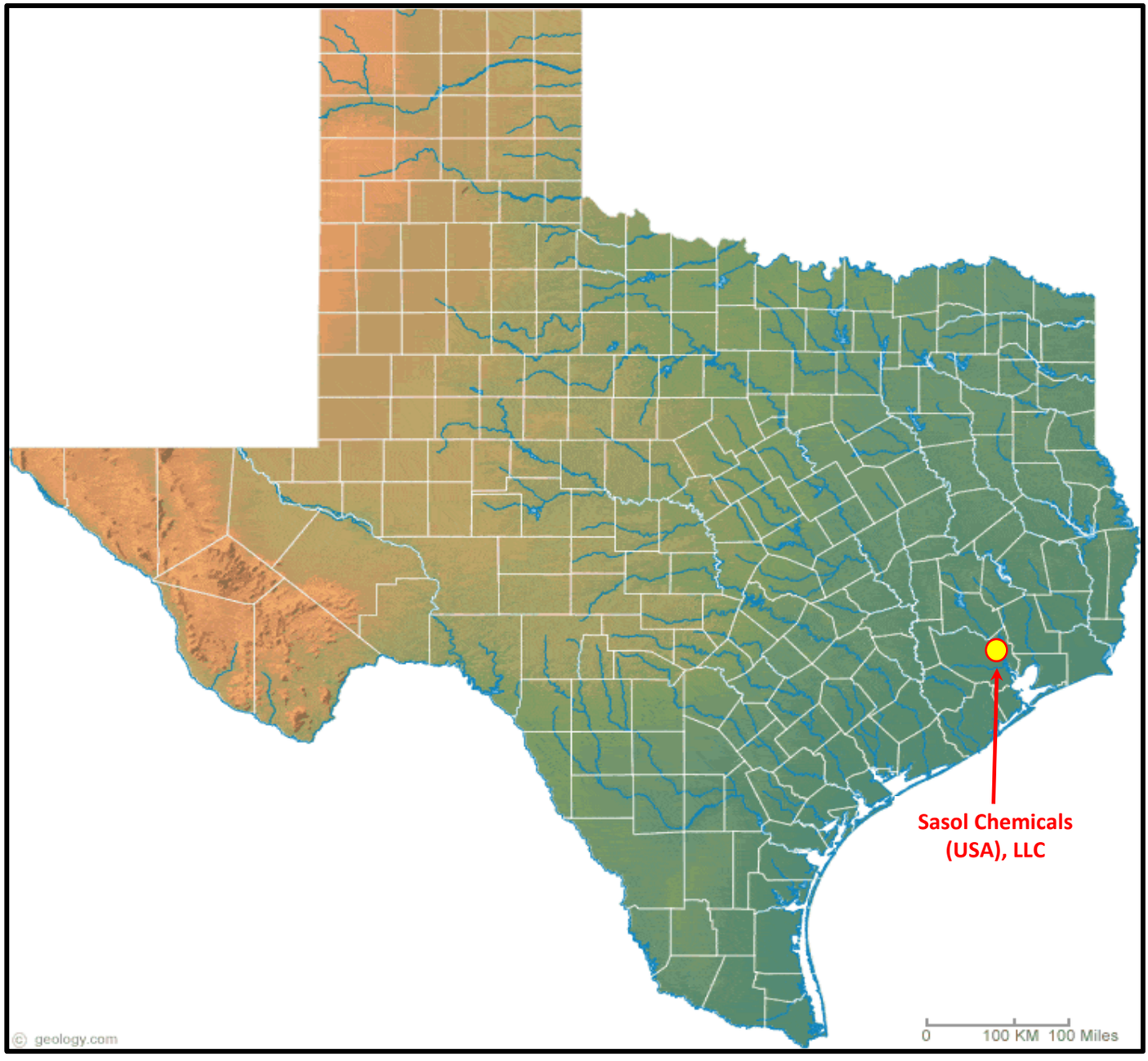


Figure 1-1 Location Map for the Sasol Chemicals (USA), LLC Greens Bayou Plant

2.5 Mile Area of Review

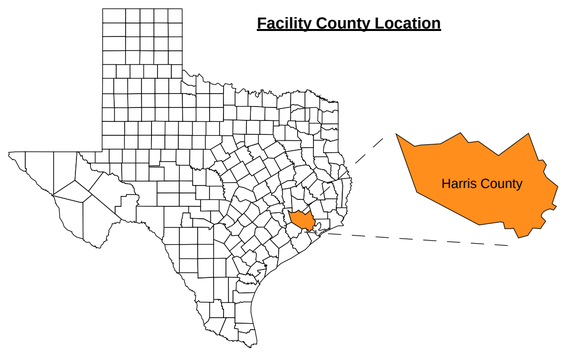
Sasol Greens Bayou Plant
Plant Boundary

Injection Well No. 2 (WDW319)

Injection Well No. 1 (WDW147)

HOUSTON
JACINTO CITY
GALENA PARK
CLOVERLEAF
CHANNELVIEW
JACINTOPORT
DEER PARK
Round Prairie
BUFFALO BAYOU

Facility County Location



LEGEND

- 2-Mile AOR
- Plant Boundary
- Injection Well

0 2000 4000 6000 8000

Scale in Feet

N

*Note: Map compiled and adapted from United States Department of the Interior Geological Survey, Topographic Map Quadrangle Texas Location Area: Settegast, Jacinto City, Highlands, Park Place, Pasadena, La Porte

**From Martin Sheets Merichem Study Draft Report

sasol reaching new frontiers

Sasol
Greens Bayou Plant
Harris County, Texas

Figure 1-2
Site Location Map

Created by: ESSJ Updated by: EDG	Scale: 1" = 2000'	Edit Date: June 2019

GEOSTOCK SANDIA ENTREPOSE
8860 Fallbrook Drive Houston, TX 77064 USA Tel: (346) 314 - 4347 Fax: (832) 478 - 5172

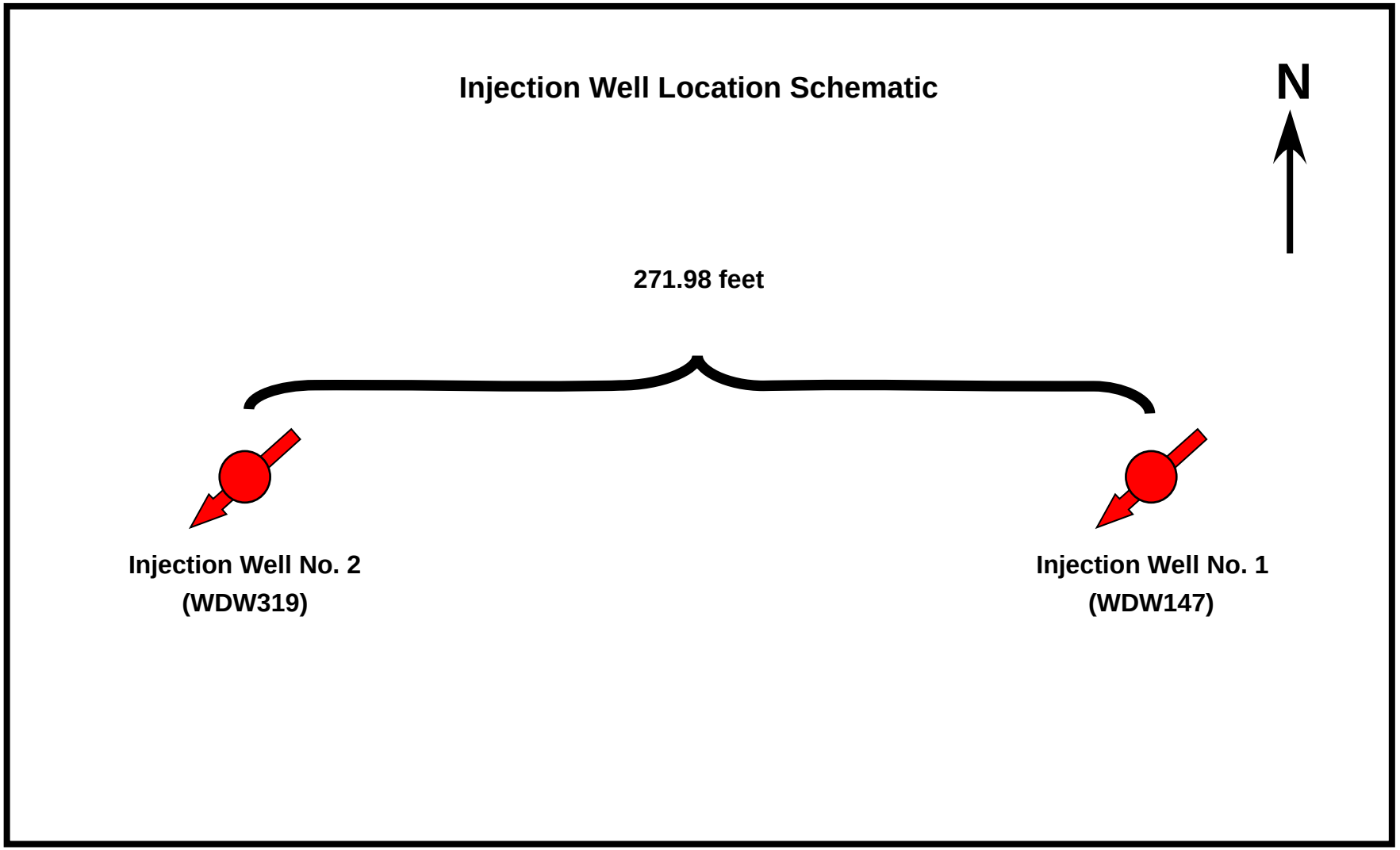


Figure 1-3 Relative Locations of Injection Well No. 2 (WDW319) to Injection Well No. 1 (WDW147)

Sasol Injection Well No. 1 (WDW147)

Injection Well - Wellbore Schematic

20" Conductor Casing
Driven to 83'

10 3/4" Surface Casing
to 2728'
(1700 sks Cement)

7" Protection Casing
to 7306'
(820 sks Cement)

4 1/2" Injection Tubing
to 6491'

6476' Baker Model
F Packer

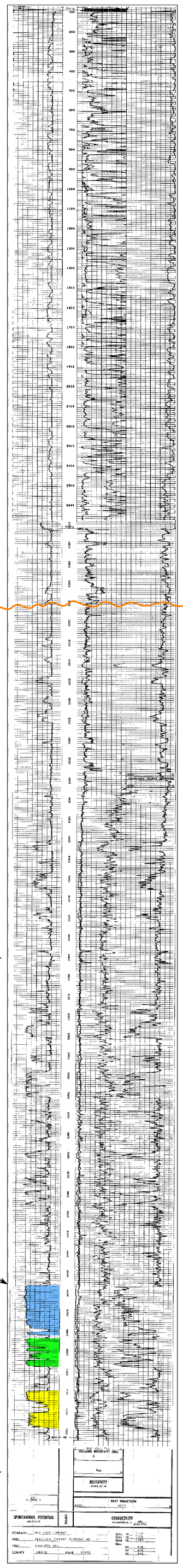
Perforations from
6620' - 6680'
6700' - 6780'

TD: 7336'

Depth (in feet BGL)

Injection Well Log

Sasol Greens Bayou Plant
Injection Well No. 1 (WDW147)
Induction-SFL Compensated Neutron - Formation Density, ISF/Sonic
8/13/1978, 8/27/1978 (Schlumberger)



- 0' -
- 1000' -
- 2000' -
Base of Lowermost USDW
(10,000 mg/l TDS)
- 3000' -
(8)
- 4000' -
Confining Zone
(7)
(1)
- 5000' -
Injection Zone
Containment
Interval
- 6000' -
(2)
(4) Gross Sand Map
Frio E & F Sand
(5) Gross Sand Map
Frio A & B Sand
Injection
Interval
- 7000' -
(6) Gross Sand Map
Frio C Sand
(3)

Base of Lowermost USDW
(10,000 mg/l TDS)

1650' Alternating Sequence of Permeable
Sand and Impermeable Shale

375' Sequence of Impermeable Shale
with Limestones Stringers

1430' Alternating Sequence of Permeable
Sand and Impermeable Shale
with 635' Net Shale (44% Shale)

Frio E & F Sand

Frio A & B Sand

Frio C Sand

Geologic and Regulatory Units

PLEISTOCENE	BEAUMONT, LISSIE & WILLIS FMS.
PLIOCENE	GOLIAD FORMATION
MIOCENE	? FLEMING GROUP ?
OLIGOCENE	ANAHUAC FM.
	FRIO FORMATION
	VICKSBURG GROUP

Geologic Maps

(1) Structural Contour Map on the Anahuac Marker
(2) Structural Contour Map on the Top of the Frio E & F Sand
(3) Structural Contour Map on the Vicksburg Marker
(4) Gross Sand Isopach Map: Frio E & F Sand
(5) Gross Sand Isopach Map: A & B Sand
(6) Gross Sand Isopach Map: C Sand
(7) Interval Isopach Map: Anahuac Formation Confining Zone
(8) Structural Contour Map on the Base of the Lowermost USDW

sasol
reaching new frontiers

Sasol
Greens Bayou Plant
Harris County, Texas

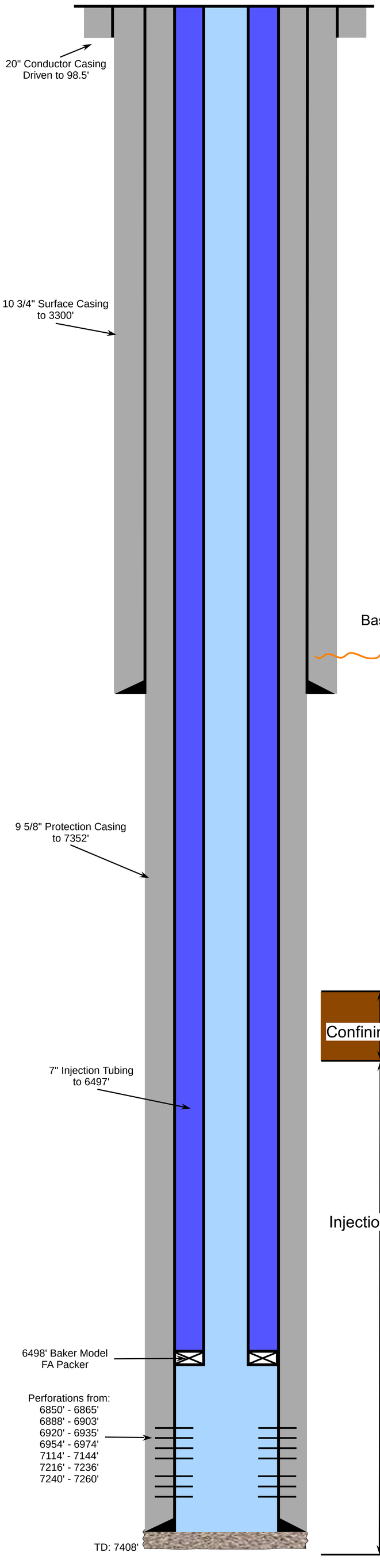
Figure 1-4
Type Log with Regulatory Intervals for Injection Well No. 1 (WDW147)

Created by: ESSJ *Updated by: EDG*	*not to scale*	*Date: June 2019*

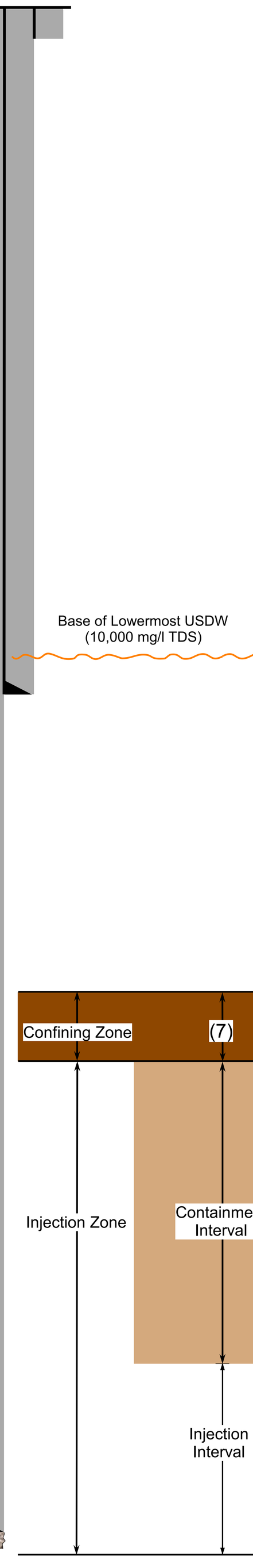
GEOSTOCK SANDIA
8860 Fallbrook Dr Houston, TX 77064 USA Tel: (346) 314-4947 Fax: (832) 478-5102

Sasol Injection Well No. 2 (WDW319)

Injection Well - Wellbore Schematic

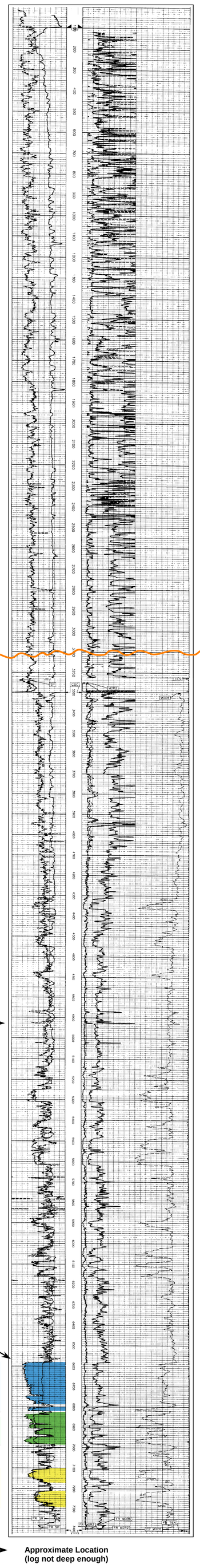


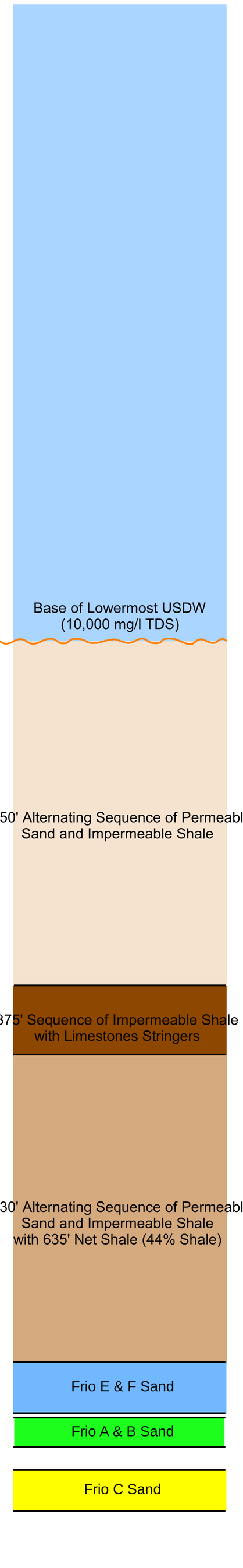
Depth (in feet BGL)



Injection Well Log

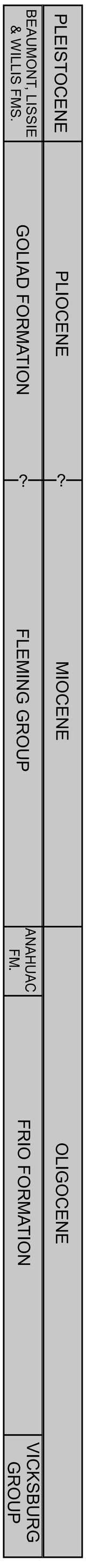
Sasol Greens Bayou Plant
Injection Well No. 2 (WDW319)
Induction-SFL Open Hole
8/31/2000 (Baker Hughes)





Approximate Location
(log not deep enough)

Geologic and Regulatory Units



Geologic Maps

(1) Structural Contour Map on the Anahuac Marker
(2) Structural Contour Map on the Top of the Frio E & F Sand
(3) Structural Contour Map on the Vicksburg Marker
(4) Gross Sand Isopach Map: Frio E & F Sand
(5) Gross Sand Isopach Map: A & B Sand
(6) Gross Sand Isopach Map: C Sand
(7) Interval Isopach Map: Anahuac Formation Confining Zone
(8) Structural Contour Map on the Base of the Lowermost USDW

sasol
reaching new frontiers

Sasol
Greens Bayou Plant
Harris County, Texas

Figure 1-5
Type Log with Regulatory Intervals for Injection Well No. 2 (WDW319)

Created by: EDG	*not to scale*	*Date: June 2019*

GEOSTOCK SANDIA
ENTREPOSE
ve Houston, TX 77064 USA Tel: (346) 314 - 4947 Fax: (832) 478 - 5172 8860 Fallbrook Dr

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316265 **Instrument: VOA6** **Method: SW8260**

MS Sample ID: **HS18050640-01MS** Units: **ug/L** Analysis Date: **16-May-2018 01:43**
Client ID: Run ID: **VOA6_316265** SeqNo: **4562513** PrepDate: DF: **20**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	918.9	100	1000	0	91.9	70 - 130				
1,1,2,2-Tetrachloroethane	905.3	100	1000	0	90.5	70 - 123				
1,1,2-Trichlor-1,2,2-trifluoroethane	901.5	100	1000	0	90.2	70 - 130				
1,1,2-Trichloroethane	948.4	100	1000	0	94.8	70 - 117				
1,1-Dichloroethane	925.4	100	1000	0	92.5	70 - 127				
1,1-Dichloroethene	896.9	100	1000	0	89.7	70 - 130				
1,2,4-Trichlorobenzene	847.9	100	1000	0	84.8	70 - 125				
1,2-Dibromo-3-chloropropane	922.1	100	1000	0	92.2	70 - 130				
1,2-Dibromoethane	991.2	100	1000	0	99.1	70 - 124				
1,2-Dichlorobenzene	919.3	100	1000	0	91.9	70 - 115				
1,2-Dichloroethane	950	100	1000	0	95.0	70 - 127				
1,2-Dichloropropane	974.1	100	1000	0	97.4	70 - 122				
1,3-Dichlorobenzene	917.1	100	1000	0	91.7	70 - 119				
1,4-Dichlorobenzene	900.6	100	1000	0	90.1	70 - 114				
2-Butanone	1857	200	2000	0	92.9	70 - 130				
2-Hexanone	1844	200	2000	0	92.2	70 - 130				
4-Methyl-2-pentanone	1872	200	2000	0	93.6	70 - 130				
Acetone	2072	200	2000	0	104	70 - 130				
Benzene	970.9	100	1000	0	97.1	70 - 127				
Bromodichloromethane	966.4	100	1000	0	96.6	70 - 124				
Bromoform	984.6	100	1000	0	98.5	70 - 129				
Bromomethane	777.4	100	1000	0	77.7	70 - 130				
Carbon disulfide	1867	200	2000	0	93.4	70 - 130				
Carbon tetrachloride	912.1	100	1000	0	91.2	70 - 130				
Chlorobenzene	972	100	1000	0	97.2	70 - 114				
Chloroethane	866.1	100	1000	0	86.6	70 - 130				
Chloroform	941.6	100	1000	0	94.2	70 - 125				
Chloromethane	736.6	100	1000	0	73.7	70 - 130				
cis-1,2-Dichloroethene	974.3	100	1000	0	97.4	70 - 128				
cis-1,3-Dichloropropene	959	100	1000	0	95.9	70 - 125				
Cyclohexane	848.3	100	1000	0	84.8	70 - 130				
Dibromochloromethane	982.8	100	1000	0	98.3	70 - 124				
Dichlorodifluoromethane	753.5	100	1000	0	75.4	70 - 130				
Ethylbenzene	965.9	100	1000	0	96.6	70 - 124				

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316265 **Instrument: VOA6** **Method: SW8260**

MS Sample ID: **HS18050640-01MS** Units: **ug/L** Analysis Date: **16-May-2018 01:43**
Client ID: Run ID: **VOA6_316265** SeqNo: **4562513** PrepDate: DF: **20**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	925.3	100	1000	0	92.5	70 - 130				
m,p-Xylene	1901	200	2000	0	95.1	70 - 130				
Methyl acetate	914.2	100	1000	0	91.4	76 - 122				
Methyl tert-butyl ether	943.7	100	1000	0	94.4	70 - 130				
Methylcyclohexane	873.8	100	1000	0	87.4	61 - 158				
Methylene chloride	1042	200	1000	0	104	70 - 128				
o-Xylene	975.2	100	1000	0	97.5	70 - 124				
Styrene	970.7	100	1000	0	97.1	70 - 130				
Tetrachloroethene	951.1	100	1000	0	95.1	70 - 130				
Toluene	960.8	100	1000	0	96.1	70 - 123				
trans-1,2-Dichloroethene	959.9	100	1000	0	96.0	70 - 130				
trans-1,3-Dichloropropene	977.5	100	1000	0	97.7	70 - 121				
Trichloroethene	965.6	100	1000	0	96.6	70 - 129				
Trichlorofluoromethane	816.4	100	1000	0	81.6	70 - 130				
Vinyl chloride	821.9	40	1000	0	82.2	70 - 130				
Xylenes, Total	2876	100	3000	0	95.9	70 - 130				
Surr: 1,2-Dichloroethane-d4	*846.5*	*0*	*1000*	*0*	*84.7*	*70 - 126*				
Surr: 4-Bromofluorobenzene	*966.6*	*0*	*1000*	*0*	*96.7*	*82 - 124*				
Surr: Dibromofluoromethane	*905.6*	*0*	*1000*	*0*	*90.6*	*77 - 123*				
Surr: Toluene-d8	*949.9*	*0*	*1000*	*0*	*95.0*	*82 - 127*				

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316265 **Instrument: VOA6** **Method: SW8260**

MSD Sample ID: **HS18050640-01MSD** Units: **ug/L** Analysis Date: **16-May-2018 02:08**
Client ID: Run ID: **VOA6_316265** SeqNo: **4562514** PrepDate: DF: **20**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	RPD %RPD	RPD Limit	Qual
1,1,1-Trichloroethane	844.6	100	1000	0	84.5	70 - 130	918.9	8.42	20	
1,1,2,2-Tetrachloroethane	858.1	100	1000	0	85.8	70 - 123	905.3	5.35	20	
1,1,2-Trichlor-1,2,2-trifluoroethane	831.2	100	1000	0	83.1	70 - 130	901.5	8.12	20	
1,1,2-Trichloroethane	905	100	1000	0	90.5	70 - 117	948.4	4.68	20	
1,1-Dichloroethane	867.4	100	1000	0	86.7	70 - 127	925.4	6.47	20	
1,1-Dichloroethene	819.7	100	1000	0	82.0	70 - 130	896.9	9	20	
1,2,4-Trichlorobenzene	965.8	100	1000	0	96.6	70 - 125	847.9	13	20	
1,2-Dibromo-3-chloropropane	935	100	1000	0	93.5	70 - 130	922.1	1.39	20	
1,2-Dibromoethane	943.9	100	1000	0	94.4	70 - 124	991.2	4.89	20	
1,2-Dichlorobenzene	918.2	100	1000	0	91.8	70 - 115	919.3	0.111	20	
1,2-Dichloroethane	871.6	100	1000	0	87.2	70 - 127	950	8.61	20	
1,2-Dichloropropane	900.6	100	1000	0	90.1	70 - 122	974.1	7.84	20	
1,3-Dichlorobenzene	912.7	100	1000	0	91.3	70 - 119	917.1	0.479	20	
1,4-Dichlorobenzene	895.3	100	1000	0	89.5	70 - 114	900.6	0.587	20	
2-Butanone	1754	200	2000	0	87.7	70 - 130	1857	5.72	20	
2-Hexanone	1727	200	2000	0	86.4	70 - 130	1844	6.51	20	
4-Methyl-2-pentanone	1691	200	2000	0	84.5	70 - 130	1872	10.1	20	
Acetone	1911	200	2000	0	95.6	70 - 130	2072	8.04	20	
Benzene	907.8	100	1000	0	90.8	70 - 127	970.9	6.72	20	
Bromodichloromethane	917.3	100	1000	0	91.7	70 - 124	966.4	5.2	20	
Bromoform	931.3	100	1000	0	93.1	70 - 129	984.6	5.57	20	
Bromomethane	959.6	100	1000	0	96.0	70 - 130	777.4	21	20	R
Carbon disulfide	1706	200	2000	0	85.3	70 - 130	1867	9.02	20	
Carbon tetrachloride	844.1	100	1000	0	84.4	70 - 130	912.1	7.74	20	
Chlorobenzene	930.9	100	1000	0	93.1	70 - 114	972	4.32	20	
Chloroethane	791.9	100	1000	0	79.2	70 - 130	866.1	8.96	20	
Chloroform	887	100	1000	0	88.7	70 - 125	941.6	5.97	20	
Chloromethane	757.4	100	1000	0	75.7	70 - 130	736.6	2.78	20	
cis-1,2-Dichloroethene	916.1	100	1000	0	91.6	70 - 128	974.3	6.15	20	
cis-1,3-Dichloropropene	921	100	1000	0	92.1	70 - 125	959	4.04	20	
Cyclohexane	787.2	100	1000	0	78.7	70 - 130	848.3	7.47	20	
Dibromochloromethane	948.2	100	1000	0	94.8	70 - 124	982.8	3.58	20	
Dichlorodifluoromethane	695.1	100	1000	0	69.5	70 - 130	753.5	8.07	20	S
Ethylbenzene	917.8	100	1000	0	91.8	70 - 124	965.9	5.1	20	

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316265 **Instrument: VOA6** **Method: SW8260**

MSD Sample ID: **HS18050640-01MSD** Units: **ug/L** Analysis Date: **16-May-2018 02:08**
Client ID: Run ID: **VOA6_316265** SeqNo: **4562514** PrepDate: DF: **20**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	893.6	100	1000	0	89.4	70 - 130	925.3	3.49	20	
m,p-Xylene	1828	200	2000	0	91.4	70 - 130	1901	3.94	20	
Methyl acetate	855.4	100	1000	0	85.5	76 - 122	914.2	6.65	20	
Methyl tert-butyl ether	887.1	100	1000	0	88.7	70 - 130	943.7	6.18	20	
Methylcyclohexane	707	100	1000	0	70.7	61 - 158	873.8	21.1	20	R
Methylene chloride	966.9	200	1000	0	96.7	70 - 128	1042	7.52	20	
o-Xylene	925.6	100	1000	0	92.6	70 - 124	975.2	5.22	20	
Styrene	935.7	100	1000	0	93.6	70 - 130	970.7	3.67	20	
Tetrachloroethene	898.2	100	1000	0	89.8	70 - 130	951.1	5.72	20	
Toluene	922.3	100	1000	0	92.2	70 - 123	960.8	4.1	20	
trans-1,2-Dichloroethene	879	100	1000	0	87.9	70 - 130	959.9	8.8	20	
trans-1,3-Dichloropropene	918.5	100	1000	0	91.8	70 - 121	977.5	6.22	20	
Trichloroethene	899.2	100	1000	0	89.9	70 - 129	965.6	7.13	20	
Trichlorofluoromethane	774.2	100	1000	0	77.4	70 - 130	816.4	5.31	20	
Vinyl chloride	754.2	40	1000	0	75.4	70 - 130	821.9	8.59	20	
Xylenes, Total	2753	100	3000	0	91.8	70 - 130	2876	4.37	20	
Surr: 1,2-Dichloroethane-d4	*804.8*	*0*	*1000*	*0*	*80.5*	*70 - 126*	*846.5*	*5.05*	*20*	
Surr: 4-Bromofluorobenzene	*942.5*	*0*	*1000*	*0*	*94.3*	*82 - 124*	*966.6*	*2.52*	*20*	
Surr: Dibromofluoromethane	*860.1*	*0*	*1000*	*0*	*86.0*	*77 - 123*	*905.6*	*5.15*	*20*	
Surr: Toluene-d8	*933*	*0*	*1000*	*0*	*93.3*	*82 - 127*	*949.9*	*1.8*	*20*	

The following samples were analyzed in this batch: HS18050449-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R315920 **Instrument: WetChem_HS** **Method: SM4500H+ B**

DUP Sample ID: **HS18050382-01DUP** Units: **pH Units** Analysis Date: **09-May-2018 17:07**
Client ID: Run ID: **WetChem_HS_315920** SeqNo: **4553977** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
pH	7.11	0.100					7.2	1.26	10	
Temp Deg C @pH	20.9	0					20.9	0	10	

The following samples were analyzed in this batch: HS18050449-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316018 **Instrument: WetChem_HS** **Method: SW1010**

LCS Sample ID: **LCS-R316018** Units: **°F** Analysis Date: **11-May-2018 11:00**
Client ID: Run ID: **WetChem_HS_316018** SeqNo: **4556530** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Ignitability	82.6	70.0	81	0	102	95 - 105				

DUP Sample ID: **HS18050375-01DUP** Units: **°F** Analysis Date: **11-May-2018 11:00**
Client ID: Run ID: **WetChem_HS_316018** SeqNo: **4556531** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Ignitability	128.6	70.0					127.6	0.781	20	

The following samples were analyzed in this batch: HS18050449-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316222 **Instrument: WetChem_HS** **Method: SW7.3.4.2**

MBLK Sample ID: **MBLK-316222** Units: **mg/Kg** Analysis Date: **15-May-2018 16:01**
Client ID: Run ID: **WetChem_HS_316222** SeqNo: **4561307** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Reactive Sulfide	ND	100								

LCS Sample ID: **LCS-316222** Units: **mg/Kg** Analysis Date: **15-May-2018 16:01**
Client ID: Run ID: **WetChem_HS_316222** SeqNo: **4561308** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Reactive Sulfide	64	10.0	100	0	64.0	20 - 120				

MS Sample ID: **HS18050502-01MS** Units: **mg/Kg** Analysis Date: **15-May-2018 16:01**
Client ID: Run ID: **WetChem_HS_316222** SeqNo: **4561310** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Reactive Sulfide	52	10.0	100	8	44.0	20 - 120				

The following samples were analyzed in this batch: HS18050449-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316225 **Instrument: UV-2450** **Method: SW7.3.3.2**

MBLK Sample ID: **MBLK-316225** Units: **mg/Kg** Analysis Date: **15-May-2018 16:11**
Client ID: Run ID: **UV-2450_316225** SeqNo: **4561340** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Reactive Cyanide	ND	100								

LCS Sample ID: **LCS-316225** Units: **mg/Kg** Analysis Date: **15-May-2018 16:11**
Client ID: Run ID: **UV-2450_316225** SeqNo: **4561341** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Reactive Cyanide	0.62	10.0	10	0	6.20	5 - 100				J

MS Sample ID: **HS18050502-01MS** Units: **mg/Kg** Analysis Date: **15-May-2018 16:11**
Client ID: Run ID: **UV-2450_316225** SeqNo: **4561343** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Reactive Cyanide	0.62	10.0	10	0.01	6.10	5 - 100				J

The following samples were analyzed in this batch: HS18050449-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: HS18050449

QC BATCH REPORT

Batch ID: R316413 **Instrument: WetChem_HS** **Method: E180.1**

MBLK Sample ID: **MBLK-R316413** Units: **NTU** Analysis Date: **09-May-2018 19:40**
Client ID: Run ID: **WetChem_HS_316413** SeqNo: **4566003** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Turbidity	ND	1.00								

LCS Sample ID: **LCS-R316413** Units: **NTU** Analysis Date: **09-May-2018 19:40**
Client ID: Run ID: **WetChem_HS_316413** SeqNo: **4566002** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Turbidity	10.8	1.00	10	0	108	90 - 110				

DUP Sample ID: **HS18050449-01DUP** Units: **NTU** Analysis Date: **09-May-2018 19:40**
Client ID: **191-082** Run ID: **WetChem_HS_316413** SeqNo: **4566004** PrepDate: DF: **10**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Turbidity	75	10.0					74.3	0.938	20	

The following samples were analyzed in this batch: HS18050449-01

Note: See Qualifiers Page for a list of qualifiers and their explanation.

Client: Sasol Chemicals (USA) LLC
Project: T605 Annual CY2018
WorkOrder: **HS18050449**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
a	Not accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
J	Analyte detected below quantitation limit
M	Manually integrated, see raw data for justification
n	Not offered for accreditation
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL/SDL

Acronym	Description
DCS	Detectability Check Study
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MBLK	Method Blank
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PDS	Post Digestion Spike
PQL	Practical Quantitaion Limit
SD	Serial Dilution
SDL	Sample Detection Limit
TRRP	Texas Risk Reduction Program

Unit Reported	Description
°F	Farenheit degrees
mg/L	Milligrams per Liter
NTU	
pH units	

CERTIFICATIONS,ACCREDITATIONS & LICENSES

Agency	Number	Expire Date
California	2919 2016-2018	31-Jul-2018
Oklahoma	2017-088	31-Aug-2018
North Carolina	624-2018	31-Dec-2018
Louisiana	03087 2017-2018	30-Jun-2018
Arkansas	88-0356	27-Mar-2019
Kansas	E-10352 2017-218	31-Jul-2018

Sample Receipt Checklist

Client Name:	SASOL 77079	Date/Time Received:	**08-May-2018 13:37**
Work Order:	HS18050449	Received by:	**PS**

Checklist completed by: *Paresh M. Giga* eSignature — 9-May-2018 Date

Reviewed by: *Corey Grandits* eSignature — 9-May-2018 Date

Matrices: **Aqueous** Carrier name: **ALS Courier**

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
TX1005 solids received in hermetically sealed vials?	Yes ☐	No ☐	N/A ☑
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	
Temperature(s)/Thermometer(s):	0.7c/0.3c U/c	IR30	
Cooler(s)/Kit(s):	43815		
Date/Time sample(s) sent to storage:	5/8/18 19:00		
Water - VOA vials have zero headspace?	Yes ☑	No ☐	No VOA vials submitted ☐
Water - pH acceptable upon receipt?	Yes ☐	No ☑	N/A ☐
pH adjusted?	Yes ☑	No ☐	N/A ☐
pH adjusted by:	Si Ma		

Login Notes: Metals pH received at >2, sample container preserved with 0.25ml HNO3 5/9/18 @ 09:50.

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

Corrective Action:

ALS Laboratory Group
10450 Stancliff Rd. #210
Houston, Texas 77099
(Tel) 281.530.5656
(Fax) 281.530.5887

Chain of Custody Form

Page __1__ of __1__

COC ID: 140176

HS18050449

Sasol Chemicals (USA) LLC
T605 Annual CY2018

ALS Project Manager:

Customer Information		Project Information		Parameter/Method Request for Analysis	
Purchase Order	9100009753	Project Name	T605 Annual CY2018	A	VOC (TCL Volatiles - SW8260C)
Work Order		Project Number		B	SVOC - SW8270D
Company Name	Sasol Chemicals (USA) LLC`	Bill To Company	Sasol Chemicals (USA) LLC	C	RCRA 8+3
Send Report To	Rod Batts	Invoice Attn.	Acounts Payable	D	Reactivity / Flashpt
Address	1914 Haden Road	Address	P.O. Box 19029	E	pH/Turbidity
				F	Texas TPH by TX1005
City/State/Zip	Houston TX 77015-6498	City/State/Zip	Houston, TX 77224-9029	G	
Phone	(832) 783-6647	Phone	(281) 588-3379	H	
Fax	(713) 428-5603	Fax		I	
e-Mail Address	rod.batts@us.sasol.com	e-Mail Address	acountspayable@us.sasol.com	J	

No.	Sample Description	Date	Time	Matrix	Pres.	# Bottles	A	B	C	D	E	F	G	H	I	J	Hold
1	#1-191-082	5/8/2018	7:00am	Aqueous	1	3x40mL	X										
2	#2-191-082	5/8/2018	7:00am	Aqueous	Neat	2 x 1 Lt		X									
3	#3-191-082	5/8/2018	7:00am	Aqueous	2	60 mL			X								
4	#4-191-082	5/8/2018	7:00am	Aqueous	Neat	500mL				X							
5	#5-191-082	5/8/2018	7:00am	Aqueous	Neat	250mL					X						
6	#6-191-082	5/8/2018	7:00am	Aqueous	1	3x40mL						X					
7																	
8																	
9																	
10																	

Sampler(s): Please Print & Sign: Jane Ji

Shipment Method:

Required Turnaround Time: [√] STD 7 Wk Days [ ] 5 Wk Days [ ] Other 2 Wk Days [ ] 24 Hour

Results Due Date:

Relinquished by:	Date:	Time:	Received by:
Jane Ji	5/8/18	1 am	
Relinquished by:	Date:	Time:	Received by (Laboratory):
	5-8-18	1357	
Logged by (Laboratory):	Date:	Time:	Checked by (Labofatory):

Notes: Include in email randy.shilling@us.sasol.com 5/3 5-8-18

Cooler Temp. 4/C 0.7

QC Package: (Check Box Below)

X	Level II: Standard QC	TRRP Checklist
	Level III: Std QC + Raw Data	TRRP Level IV
	Level IV: SW846 CLP-Like	
	Other:	

Preservative Key: 1-HCL 2-HNO3 3-H2SO4 4-NaOH 5-Na2S2O3 6-NaHSO4 7-Other 8-4 degrees C 9-5035

Note: Any changes must be made in writing once samples and COC Form have been submitted to ALS Envioronmental. SRM 30

43815 CF-0.4

ALS
10450 Stancliff Rd., Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887

43815

CUSTODY SEAL

Date: 5/8/18 Time: 7am

Name: Jane J.

Company: Sasol Chemical USA

Seal Broken By: SM

Date: 05/08/18

43815 MAY 08 2018

APPENDIX 1-2
APPROVAL LETTERS FOR HAZARDOUS WASTE DISPOSAL RESTRICTIONS PETITIONS EXEMPTIONS
SASOL CHEMICALS (USA), LLC GREENS BAYOU PLANT

APPENDIX 1-2
HWDIR APPROVAL LETTER (WDW147)
DECEMBER 2, 1994

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

December 2, 1994

CERTIFIED MAIL P885 488 112 RETURN RECEIPT REQUESTED

Chris Lancaster
Plant Manager
Merichem Company
1914 Haden Road
Houston, Texas 77015

Re: Final Merichem Company Petition Decision

Dear Mr. Lancaster:

Effective the date of this letter, the Environmental Protection Agency (EPA) approves the Merichem Company exemption to the land disposal restrictions imposed by the Hazardous and Solid Waste Amendments of 1984 to the Resource Conservation and Recovery Act.

The land disposal restrictions prohibit the injection of hazardous waste unless a petitioner can demonstrate to the EPA, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the injection zone for as long as the wastes remain hazardous. The land disposal restrictions for injection wells which are codified in 40 CFR Part 148, provide the standards and procedures by which petitions to dispose of an otherwise prohibited waste by injection will be reviewed and by which exemptions pursuant to these petitions will be granted or denied.

A letter dated October 4, 1994, informed Merichem Company that the EPA would propose to approve the Merichem Company petition for an exemption to the land disposal restrictions. The public comment period associated with this proposed decision began on October 6, 1994, and closed on November 21, 1994. In addition to this comment period, a question and answer period was held in Houston, Texas on October 20, 1994, and a public hearing was held in Houston, Texas, on November 7, 1994, to allow the local public the opportunity to present comments concerning the EPA's proposed decision.

Based on a detailed technical review of the submitted petition and support documents, EPA has determined that the Merichem Company petition meets the requirements of 40 CFR Part 148 demonstrating no migration of hazardous constituents from the injection zone for 10,000 years.

The following are conditions of this land disposal restriction exemption:

Petition Approval Conditions

The approval to allow injection of restricted hazardous wastes is subject to the following conditions. Noncompliance with any of these conditions is grounds for termination of the exemption in accordance with 40 CFR 148.24(a)(1).

1. Injection of restricted waste shall be limited to the following injection interval and injection zone:

Well	Injection Interval	Injection Zone
WDW-147	6564' - 6790'	5135' - 7340'

(All depths referenced to WDW-147 ISF/Sonic log)

2. The monthly average flow rate shall not exceed the following value:

Well	Monthly Average Flow Rate
WDW-147	400 gpm

3. The facility shall cease injection by December 31, 2010.

4. The characteristics of the injected waste stream shall at all times conform to those of Sections 1.1, 2.4, 3.4 and 4.3 in the petition. The density of the waste stream shall remain within a range of from 1.060 to 1.246 g/cm^3 inclusive, at 68°F (1.040 - 1.223 g/cm^3 at 150°F).

5. The approval for injection is limited to the following hazardous wastes:

D002	D024	U018	U052	U101	U196
D003	D025	U019	U063	U120	U220
D018	D026	U022	U070	U137	U239
D021	D038	U037	U071	U165	F002
D023	U012	U050	U072	U188	F005

and F039 (for the constituents listed in Section 1.1 and Table 3-4 of the petition for F039).

6. The facility must petition for approval to inject additional hazardous wastes which are not included in Condition No. 5, above. The facility must also petition for approval to increase the concentration of any waste which would necessitate the recalculation of the limiting concentration reduction factor and the extent of the waste plume. Petition modification or reissuance should be made pursuant to §148.20 (e) or (f).

7. Merichem shall annually submit to EPA the results of a bottom hole pressure survey for WDW-147. This survey shall have been performed after shutting in the well for a period of time sufficient to allow the pressure in the injection interval to reach equilibrium, in accordance with §146.68(e)(1). This annual report should include a comparison of reservoir parameters determined from the falloff test with parameters used in the approved no migration petition.

8. Upon the expiration, cancellation, reissuance, or modification of the Texas Natural Resource Conservation Commission's Underground Injection Control permit for Well No. WDW-147, this exemption is subject to review. A new demonstration may be required if information shows that the basis for granting the exemption is no longer valid.

In addition to the above conditions, this petition approval is contingent on the validity of the information submitted in the Merichem Company petition for an exemption to the land disposal restrictions. This approval is subject to termination upon receipt of new information which shows that the basis for approval of the petition is no longer valid, in accordance with 40 CFR 148.24(a)(3).

If you have any questions or comments, please call Phil Dellinger at (214) 665-7142.

Sincerely yours,

Myron O. Knudson, P.E.
Director
Water Management Division (6W)

Enclosures

cc: Francoise Brasier (4604)
Gerald Delavan (ADPCE)

PUBLIC NOTICE OF A PROPOSED HAZARDOUS WASTE EXEMPTION

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 6
FIRST INTERSTATE BANK TOWER
1445 ROSS AVENUE
DALLAS, TEXAS 75202-2733

The U.S. Environmental Protection Agency (EPA), Region 6, proposes to approve a petition for an exemption to the land disposal restrictions of the Hazardous and Solid Waste Amendments of 1984 (HSWA) to the Resource Conservation and Recovery Act (42 U.S.C. §6901, et seq) for the following injection well facility:

Merichem Company
1914 Haden Road
Houston, Texas 77015

Facility Location: Haden Road Plant
Injection Well Permit Number: WDW-147

Development of the proposed decision was based on a detailed technical review of the submitted petition with support documents.

The HSWA Amendments provide that an exemption to these restrictions may be granted if the Administrator determines that the method of land disposal (i.e. injection well) is protective of human health and the environment. A method of land disposal may not be determined to be protective, "unless, upon application by an interested person, it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" [42 U.S.C. § 6924 (g)(5)]. Regulations establishing the criteria for petitioning for an exemption to the land disposal restrictions were published in Volume 53, Number 143 of the Federal Register, July 26, 1988, [53 Fed. Reg., 28118, (1988)]. Those regulations are now codified at C.F.R. Part 148.

A final decision to approve or deny the petition for an exemption to the land disposal restrictions will be made after the close of the comment period, which ends at close of business on November 21, 1994.

All persons, including the applicant, who wish to comment on the proposed decision to approve the exemption may do so by submitting comments, along with their name and address, to

the EPA address shown below. All written comments must be postmarked by November 21, 1994, to be considered in formulating a final decision.

A public hearing is scheduled at 6:30 p.m. on Monday, November 7, 1994, in the Wheeler Building at the San Jacinto College North, 5800 Uvalde Street, Houston, Texas. Anyone needing special provisions at the hearing site due to disabilities (i.e. interpreters for the hearing impaired, wheelchair access, etc.), is requested to contact the EPA, within ten (10) working days of the hearing date, at the address below so that these services can be provided.

In addition to the public hearing, EPA representatives will be available to answer questions pertaining to EPA's proposed decision from 2:00 pm to 6:00 pm on October 20, 1994, in the Harris County Public Library, Wood Forest Branch, located at 13601 Wood Forest Blvd, Houston, Texas.

Written comments, requests for information regarding the proposed decision on the petition, and requests for copies of the fact sheet (description of the reasons supporting the proposed decision) should be sent to EPA Region 6 at the address shown below. Information on this proposed decision may also be obtained by contacting Minnie Howard at (214) 665-7189.

U.S. Environmental Protection Agency - Region 6
Water Supply Branch (6W-SU)
1445 Ross Avenue
Dallas, Texas 75202-2733

The administrative record for this petition decision is available for review beginning October 6, 1994, between 8:00 a.m. and 4:00 p.m.; Monday through Friday, for the extent of the comment period, at the address above. A copy of the final petition is also available for review at the Harris County Public Library during normal business hours at the following location:

Harris County Public Library
Wood Forest Branch
13601 Wood Forest Blvd
Houston, Texas 77015
(713) 453-8188

Pertinent EPA comment and public hearing procedures may be found in 40 CFR 124.10 and 124.12.

The EPA will notify the applicant and each person who has submitted written comments of the final exemption decision. The final decision will also be published in the Federal Register.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

KLB
MWG
file

October 4, 1994

CERTIFIED MAIL P 239 541 608 RETURN RECEIPT REQUESTED

REPLY TO: 6W-SU

Chris Lancaster
Plant Manager
Merichem Company
1914 Haden Road
Houston, Texas 77015

RE: Proposed Petition Decision

Dear Mr. Lancaster:

Based on a detailed technical review of the submitted petition with support documents, I am proposing to approve your petition. This petition is seeking an exemption to the land disposal restrictions of the Hazardous and Solid Waste Amendments of 1984, to the Resource Conservation and Recovery Act. Enclosed are the public notice and the fact sheet document associated with this proposed decision. A final decision regarding the Merichem Company petition will be made after the end of the public comment period.

We appreciate the cooperation shown by you and your staff during the detailed petition review process. If you have any questions or comments regarding this matter, please call Phil Dellinger at (214) 665-7142.

Sincerely yours,

Myron O. Knudson, P.E.
Director
Water Management Division (6W)

Enclosures

cc: Francoise Brasier (4604)
Ben Knape, TNRCC

October 4, 1994

FACT SHEET

For proposed approval to allow injection of restricted hazardous wastes into the following injection well (WDW-147):

Applicant: Merichem Company
4800 Texas Commerce Tower
Houston, TX 7002-3068

Facility Location: Haden Road Plant

Permit Numbers: WDW-147
WDW-319 (proposed)

Issuing Office: U.S. Environmental Protection Agency
Region 6
First Interstate Bank Tower
1445 Ross Avenue
Dallas, TX 75202-2733

Decision

The Environmental Protection Agency (EPA) proposes to allow the injection of restricted hazardous wastes into the injection well (WDW-147) described in the petition demonstration document. The following is an explanation of the derivation of the proposed decision, which is categorized according to the criteria outlined in 40 CFR Part 148. [53 Fed. Reg., 28118, (1988)]

Summary

The EPA land disposal restrictions promulgated under §3004 of the Resource Conservation and Recovery Act prohibit the injection of hazardous waste unless a petitioner demonstrates to the EPA that there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous or 10,000 years. These no migration demonstrations include a description of the well operations, geologic siting, and waste stream characteristics. They also utilize computer modeling and mathematical equations which incorporate all the above mentioned information to predict pressure build up and subsurface waste movement.

The Merichem Company (Merichem) petition described its well operation through a discussion of the well construction, injection pressures, and injection volumes. The site location

and geologic conditions were presented through a discussion of the depositional environments, well logs, cross-sections, well tests, geologic maps, and well records. The characteristics of the injection waste stream were described and evaluated for compatibility with the injection and confining zones. Merichem incorporated all this information into a modeling strategy which predicted the pressure build up and waste movement for the Haden Road Facility.

The waste plume, under worst conditions, was predicted to move laterally approximately 5.1 miles down gradient to the southeast, 10 miles downdip to the south, and 3.3 miles updip to the northwest from the plant site in 10,000 years. Maximum vertical movement is approximately 520 feet in a mud filled borehole. All of these distances are within the injection zone.

In addition to the reasonably conservative data and assumptions in the no migration demonstration, the following factors augment the demonstration of no migration:

(a) The petition over predicts pressure buildup and waste plume extent by modeling the following injection rates:

800 gpm - Frio E and F sand (WDW-147 and WDW-319 (proposed))
400 gpm - Frio A and B sand (WDW-319 (proposed))
400 gpm - Frio C sand (WDW-319 (proposed))

(b) The facility over predicts the injected hazardous constituent concentration by assuming a constituent concentration of 100 percent.

(c) This demonstration is conservative by not taking into account the degradation of the contaminant in the injection zone. Examples of degradation which were not considered are adsorption, oxidation, hydrolysis, temperature, and microbiological degradation.

(d) In the evaluation of artificial penetrations, the petition does not take into account the occurrence of natural wellbore closure. This occurs within the Gulf Coast region due to the unconsolidated sediments.

Therefore, after a detailed and thorough review of the petition, the EPA proposes that Merichem has demonstrated, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the injection zone for a time period of 10,000 years.

Merichem has requested approval to inject hazardous waste into the existing well at the facility, WDW-147, and for the proposed well, WDW-319. This proposed approval is only for well WDW-147. Upon drilling and completion of WDW-319, Merichem may request approval by demonstrating the reservoir parameters used in the pressure buildup and plume movement demonstration remain valid and the well has passed mechanical integrity. Any proposed decision for WDW-319 will require a petition modification with a separate public comment period. Merichem has elected to include the injection into the proposed well, WDW-319, in the modeling demonstration at this time. The existing well, WDW-147, is injecting into the Frio E-F sands. The proposed well, WDW-319 is modeled for injection into the Frio E-F, Frio A-B, and Frio C sands.

The factors considered in the formulation of this proposed petition decision are described below.

Artificial Penetrations

The area around the Class I hazardous waste well cited in the petition must be evaluated to ensure that the injection activity will not endanger Underground Sources of Drinking Water (USDWs) by causing movement of fluids into improperly sealed, completed, or abandoned wells. The petition applicant submitted information on all wells penetrating the injection or confining zones within 2.5 miles of the injection well. This information indicated that the artificial penetrations within the 2.5 mile radius are plugged or constructed to prevent endangerment to a USDW. There are 11 such wells in the Area of Review (AOR) which meet this standard. The calculated Cone of Influence (COI) diameter in the Frio E-F is less than 120', the COI diameter in the Frio A-B is less than 660', and the COI diameter in the Frio C is less than 15,400'.

In addition to the non-endangerment standard, some artificial penetrations must also meet the no migration standard. These artificial penetrations are wells which penetrate the injection zone and are located within the area of the waste plume movement over 10,000 years. The wells meeting these criteria for the Merichem site are plugged or constructed to prevent the migration of hazardous waste from the injection zone. There are 18 wells within the area of the plume which meet the no migration standard. All wells met this standard through a demonstration that waste movement due to pressure and molecular diffusion in an artificial penetration will remain within the injection zone.

Mechanical Integrity Testing (MIT) Information

To assure that the wastes will reach the injection zone, a petitioner must submit the results of pressure and radioactive tracer tests according to §148.20 (a)(2)(iv). A well has mechanical integrity when there is no significant leak in the casing, tubing, or packer, and when there is no significant fluid movement into a USDW through vertical channels adjacent to the injection well bore. The petition demonstrates that Well WDW-147 has been tested and satisfies the above criteria.

Well No.	Date of Pressure Test	Date of Radioactive Tracer Survey
WDW-147	September 14, 1993	September 16, 1993

Quality Assurance

According to §148.21 (a)(4), the Merichem petition demonstrates that proper quality assurance and quality control plans were followed in preparing the petition demonstrations.

Specifically, Merichem has followed appropriate protocol in identifying and locating records for artificial penetrations within the AOR. Information regarding the geology, waste characterization, hydrology, reservoir modeling, and well construction has also been adequately verified or bounded by worst-case scenarios.

Regional and Local Geology

Class I hazardous waste injection wells must be located in areas that are geologically suitable. The injection zone must have sufficient permeability, porosity, thickness, and areal extent to prevent migration of fluids into USDWs. The confining zone must be laterally continuous and free of transmissive faults or fractures to prevent the movement of fluids into a USDW and must contain at least one formation capable of preventing vertical propagation of fractures. The Merichem facility is sited in an area meeting the above criteria.

An evaluation of the structural and stratigraphic geology of the local and regional area has determined that the Merichem facility is located at a geologically suitable site. The injection zone is of sufficient permeability, porosity, thickness, and areal extent to meet requirements stated in 40 CFR Part 148. The confining zone is laterally continuous and free of transecting, transmissive faults or fractures over an area sufficient to prevent the movement of fluids into a USDW.

The geologic conditions for the Merichem site were presented through a discussion of the depositional environments, well logs, cross-sections, well tests, and geologic maps. The geologic cross-sections demonstrated the lateral relationships of the injection and confining zones, justifying some of the modeling assumptions. Well test data, conventional core, and sidewall core data support the injection zone permeability parameters in the modeling strategies.

Depths to the tops of the geologic zones are as follows (all depths are referenced to WDW-147 ISF/Sonic Log):

Depth of Confining Zone:
WDW-147: 4760′ - 5135′ (Anahuac Formation)
WDW-319 (proposed): 4760′ - 5135′ (Anahuac Formation)

Depth of Injection Zone:
WDW-147: 5135′ - 7340′ (Frio Formation)
WDW-319 (proposed): 5135′ - 7340′ (Frio Formation)

Depth of Injection Interval:
WDW-147: 6564′ - 6790′ (Frio E and F sand)
WDW-319 (proposed): 6564′ - 6790′ (Frio E and F sand)
6848′ - 6980′ (Frio A and B sand)
7100′ - 7240′ (Frio C sand)

Hydrogeology

According to §148.20 (a)(1), a petitioner must submit hydrogeologic information in order to study the effects of the injection well activity. Merichem provided hydrogeologic information in the petition which demonstrates that USDWs are properly protected. The base of the lowermost USDW is at approximately 3070′ subsea.

Characteristics of Injected Fluids

According to §148.22 (a), the characteristics of the injection waste stream must be adequately described in order to determine the waste stream's compatibility with the injection zone. These characteristics are described in the petition and the description is adequate and complete.

The waste is characterized by the following EPA hazardous waste codes:

D002	D024	U018	U052	U101	U196
D003	D025	U019	U063	U120	U220
D018	D026	U022	U070	U137	U239
D021	D038	U037	U071	U165	F002
D023	U012	U050	U072	U188	F005

F039 (F039 containing only the constituents listed in Section 1.1 and Table 3-4 of the petition).

Geochemistry and Injected Waste Compatibility

According to §148.21 (b)(5), a petitioner must describe the geochemical conditions of the well site. The physical and chemical characteristics of the injection zone and the formation fluids in the injection zone were described in the petition. This description included a discussion of the compatibility of the injected waste with the injection zone. The geochemistry of the injection zone was described through the use of core analyses. Merichem also provided evaluations which demonstrated that the waste stream would not adversely alter the confining capabilities of the injection and confining zones.

Modeling Strategy

According to 40 CFR §148.21(a)(3), in demonstrating no migration of hazardous constituents from the injection zone, predictive models shall have been verified and validated, shall be appropriate for the specific site and waste streams, and shall be calibrated for existing sites. The modeling strategy consisted of a combination of numerical and analytical models. All the models used were identified as being verified and validated according to the information submitted in the petition. This information consisted of actual model documentation or references of methods or techniques that are widely accepted by the technical community. The petition describes the predictive models used and demonstrates that the above criteria are met.

According to 40 CFR §148.21(a)(5), reasonably conservative values shall be used whenever values taken from the literature or estimated on the basis of known information are used instead of site-specific measurements. Many variables were required to be quantified in order to employ the models used in the petition. All parameters were conservatively assigned to produce worst case conditions for either pressure buildup or waste movement.

According to 40 CFR §148.21 (a)(6), a petitioner must perform a sensitivity analysis in order to determine the effect of uncertainties associated with model parameters. Merichem provided this sensitivity analysis in its petition. Through conservative model parameter assignments within this analysis, worst case scenarios for pressure buildup and waste movement were investigated and reported.

Results

1. Operational Life:

End of Operational Life: December 31, 2010
Maximum Permitted Injection Rates:
Frio E and F: 800 gpm
Frio A and B: 400 gpm
Frio C: 400 gpm
Maximum Pressure Buildup:
Frio E and F: 195 psi
Frio A and B: 312 psi
Frio C: 514 psi
Maximum Lateral Waste Movement:
Frio E and F: .86 miles
Frio A and B: .72 miles
Frio C: 1.0 mile
Maximum Vertical Waste Movement:
Above the Frio E and F: 8.23'

2. 10,000 Year Post-Injection Period:

Background Gradient: 1.6 ft/yr
Waste Density Effects Considered: Yes
Movement Due to Hydrocarbon Production: No
Waste Concentration Reduction Factor: $1x10^{-8}$.
Maximum Lateral Waste Movement:
Regional Drift:
Approximately 26,800 ft, 5.3 miles in southeast direction from the plant
Density Differences in the Heavy Plume:
Approximately 53,500 ft, 10 miles south of the plant (downdip). Model reached a structural low in approximately 3000 years and structurally contained from that point in time.
Density Difference in the Light Plume:
Approximately 17,600 ft, 3.3 miles in a northwest direction from the plant (updip)
Maximum Vertical Waste Movement: Approximately 163' through shale and 518' in a mud filled borehole.

Approval for well WDW-319 (proposed) is contingent on a Merichem showing the reservoir parameters used in the pressure buildup and plume movement demonstration remain valid and the well has passed mechanical integrity. This proposed approval is only for well WDW-147.

Proposed Petition Approval Conditions

The proposed approval to allow injection of restricted hazardous wastes is subject to the following conditions. Noncompliance with any of these conditions is grounds for termination of the exemption in accordance with 148.24(a)(1).

1. Injection of restricted waste shall be limited to the following injection interval and injection zone:

Well	Injection Interval	Injection Zone
WDW-147	6564' - 6790'	5135' - 7340'

(All depths referenced to WDW-147 ISF/Sonic log)

2. The monthly average flow rate shall not exceed the following value:

Well	Monthly Average Flow Rate
WDW-147	400 gpm

3. The facility shall cease injection by December 31, 2010.

4. The characteristics of the injected waste stream shall at all times conform to those of Sections 1.1, 2.4 3.4 and 4.3 in the petition. The density of the waste stream shall remain within a range of from 1.060 to 1.246 g/cm^3 inclusive, at 68°F (1.040 - 1.223 g/cm^3 at 150°F).

5. The proposed approval for injection is limited to the following hazardous wastes:

D002	D024	U018	U052	U101	U196
D003	D025	U019	U063	U120	U220
D018	D026	U022	U070	U137	U239
D021	D038	U037	U071	U165	F002
D023	U012	U050	U072	U188	F005

and F039 (For the constituents listed in Section 1.1 and Table 3-4 of the petition for F039).

6. The facility must petition for approval to inject additional hazardous wastes which are not included in Condition No. 5, above. The facility must also petition for approval to increase the concentration of any waste which would necessitate the recalculation of the limiting concentration

reduction factor and the extent of the waste plume. Petition modifications and reissuance should be made pursuant to §148.20 (e) or (f).

7. Merichem shall annually submit to EPA the results of a bottom hole pressure survey for WDW-147. This survey shall have been performed after shutting in the well for a period of time sufficient to allow the pressure in the injection interval to reach equilibrium, in accordance with §146.68(e)(1). This annual report should include a comparison of reservoir parameters determined from the falloff test with parameters used in the approved no migration petition.

8. Upon the expiration, cancellation, reissuance, or modification of the Texas Natural Resource Conservation Commission's Underground Injection Control permit for Well No. WDW-147, this exemption is subject to review. A new demonstration may be required if information shows that the basis for granting the exemption is no longer valid.

In addition to the above conditions, this proposed petition approval is contingent on the validity of the information submitted in the Merichem petition for an exemption to the land disposal restrictions. This approval is subject to termination upon receipt of new information which shows that the basis for approval of the petition is no longer valid, in accordance with §148.24(a)(3).

APPENDIX 1-2
HWDIR APPROVAL LETTER (WDW319)
DECEMBER 22, 2000

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

December 22, 2000

CERTIFIED MAIL 7000 0520 0021 8610 7779 RETURN RECEIPT REQUESTED

Mr. Kenneth P. Morgan
Corporate Environmental Manager
MERISOL USA LLC
1914 Haden Road
Houston, TX 77015-6498

Re: Final Injection Well No Migration Exemption Reissuance Decision

Dear Mr. Morgan:

This letter is to notify you that the Environmental Protection Agency (EPA) approves the reissuance request for exemption to the land disposal restrictions for injection well WDW-319 located at the MERISOL USA LLC, (Merisol) facility in Houston, Texas. This approval is effective December 27, 2000. This action also terminates the use of the existing well, WDW-147, after this date.

The land disposal restrictions prohibit the injection of hazardous waste unless a petitioner can demonstrate to the EPA, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the injection zone for as long as the wastes remain hazardous. The land disposal restrictions for injection wells codified in 40 CFR Part 148, provide the standards and procedures by which petitions to dispose of an otherwise prohibited waste by injection will be reviewed, and by which exemptions pursuant to these petitions will be granted or denied.

A letter dated October 26, 2000, informed MERISOL that the EPA was proposing to approve the MERISOL petition reissuance request for an exemption to the land disposal restrictions and the date and location of the public hearing. The public comment period associated with this decision began on October 30, 2000, and closed on December 18, 2000. Additionally, the public hearing was held on November 30, 2000, at the San Jacinto North College located in Houston, Texas. No comments were received.

Based on a detailed technical review of the submitted petition and support documents, the EPA has determined that this information for the Merisol facility meets the requirements of 40 CFR Part 148 by demonstrating no migration of hazardous constituents from the injection zone for 10,000 years.

The following are conditions of this exemption to the land disposal restrictions:

Petition Approval Conditions

The approval to allow injection of restricted hazardous wastes is subject to the following conditions, which are necessary to assure that the standard in 40 CFR §148.20(a) is met. Noncompliance with any of these conditions is grounds for termination of the exemption in accordance with 40 CFR §148.24(a)(1). This exemption reissuance applies to well WDW-319, and specifies termination of WDW-147 for no migration exemption use.

1. Injection of restricted waste shall be limited to the following injection interval and injection zone:

Injection Zone:	5134 - 7410 feet
Injection Intervals:	6580 - 6795 feet - Frio E-F
	6830 - 6984 feet - Frio A-B
	7100 - 7290 feet - Frio C

(All depths are referenced to WDW-319 Baker Atlas Induction Log dated August 31, 2000)

2. The monthly average flow rate for WDW-319 shall not exceed 400 gpm.

3. The facility shall cease injection by December 31, 2010.

4. The characteristics of the injected waste stream shall at all times conform to those of Sections 1.1, 2.4, 3.4, and 4.3 in the petition. The density of the waste stream shall remain within a range of from 1.060 to 1.246 g/cm^3 inclusive, at 68°F (1.040 - 1.223 g/cm^3 at 150°F).

5. The approval for injection is limited to the following hazardous wastes:

D002	D024	U018	U052	U101	U196
D003	D025	U019	U063	U120	U220
D018	D026	U022	U070	U137	U239
D021	D038	U037	U071	U165	F002
D023	U012	U050	U072	U188	F005

and F039 (For the constituents listed in Section 1.1 and Table 3-4 of the 1994 petition for F039 and Table 1-2 of the 2000 petition reissuance).

6. The facility must petition for approval to inject additional hazardous wastes which are not included in Condition No. 5, above. The facility must also petition for approval to increase the concentration of any waste which would necessitate the recalculation of the limiting concentration reduction factor and the extent of the waste plume. Petition reissuance and modifications should be made pursuant to §148.20 (e) or (f).

7. Merisol shall annually submit to EPA the results of a bottom hole pressure survey for WDW-319. This survey shall have been performed after shutting in the well for a period of time sufficient to allow the pressure in the injection interval to reach equilibrium, in accordance with §146.68(e)(1). This annual report should include a comparison of reservoir parameters determined from the falloff test with parameters used in the approved no migration petition.

8. Upon the expiration, cancellation, reissuance, or modification of the Texas Natural Resource Conservation Commission's Underground Injection Control permit for Well No. WDW-319, this exemption is subject to review. A new demonstration may be required if information shows that the basis for granting the exemption is no longer valid under 40 CFR §148.23 and §148.24.

In addition to the above conditions, this petition approval is contingent on the validity of the information submitted in the Merisol petition for an exemption to the land disposal restrictions. This approval is subject to termination when any of the conditions occur which are listed in 40 CFR §148.24, including noncompliance, misrepresentation of relevant facts, or a determination that new information shows that the basis for approval is no longer valid.

If you have any questions or comments, please call Philip Dellinger at (214) 665-7165.

Sincerely yours,

Sam Becker
Acting Division Director
Water Quality Protection Division

cc: Bruce Kobelski, USEPA OGWDW
Ben Knape, TNRCC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

October 26, 2000

CERTIFIED MAIL 7000 0520 0021 8610 7694 RETURN RECEIPT REQUESTED

REPLY TO: 6WQ-SG

Mr. Kenneth P. Morgan
Corporate Environmental Manager
MERISOL USA LLC
1914 Haden Road
Houston, TX 77015-6498

RE: Proposed Injection Well Petition Reissuance Decision

Dear Mr. Morgan:

We have reviewed your October 19, 2000, request for reissuance of the approved exemption to the land disposal restrictions for the MERISOL USA LLC, Houston, Texas facility. Based upon the detailed review of all pertinent information, I am proposing to approve the request. Enclosed are the public notice and the fact sheet associated with this proposed decision. A final decision regarding this reissuance will be made after the end of the public comment period.

We appreciate the cooperation shown by you and your staff during the reissuance review process. If you have any questions or comments regarding this matter, please call Philip Dellinger at (214) 665-7165.

Sincerely yours,

Sam Becker
Acting Director
Water Quality Protection Division

Enclosures

cc: Ben Knape, TNRCC

PUBLIC NOTICE OF A PROPOSED REISSUANCE OF
A HAZARDOUS WASTE EXEMPTION

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 6
FOUNTAIN PLACE
1445 ROSS AVENUE
DALLAS, TEXAS 75202-2733

The U.S. Environmental Protection Agency (EPA), Region 6, proposes to reissue an exemption to the land disposal restrictions of the Hazardous and Solid Waste Amendments of 1984 (HSWA) to the Resource Conservation and Recovery Act (42 U.S.C. §6901, et seq.) for the following facility:

MERISOL USA LLC
Greens Bayou Facility

Facility Location: 1914 Haden Road
Houston, TX 77015-6498

Injection Well Permit Number: WDW-319

Development of the proposed decision was based on a detailed technical review of the submitted petition and reissuance request with support documents.

The land disposal restrictions of HSWA prohibit the injection of restricted hazardous waste. However, these amendments provide that an exemption to these restrictions may be granted if the Administrator determines that the method of land disposal (i.e., injection well) is protective of human health and the environment. A method of land disposal may not be determined to be protective, "unless, upon application by an interested person, it has been demonstrated to the Administrator, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" [42 U.S.C. §6924(g)(5)]. Regulations establishing the criteria for petitioning for an exemption to the land disposal restrictions were published in Volume 53, Number 143 of the Federal Register, July 26, 1988, [53 Fed. Reg., 28118, (1988)]. These regulations are now codified at 40 C.F.R. Part 148. MERISOL USA LLC (Merisol), successfully demonstrated no migration for injection well WDW-147 at its Houston, Texas facility and obtained an exemption to the land disposal restrictions on December 2, 1994. This demonstration included modeling for the then proposed well WDW-319 as well as WDW-147.

The regulations described above also allow for reissuance of an approved petition if the reissuance also meets the no migration criteria in these regulations. In its reissuance request, Merisol demonstrated that the approved no migration petition continues to remain valid with the addition of the newly drilled injection well, WDW-319. This proposed decision will also terminate the use of the existing well, WDW-147, due to the lack of a mechanical integrity demonstration within one year of this petition reissuance request. Merisol may request approval for WDW-147 by

demonstrating the well has passed mechanical integrity. Any proposed decision for WDW-147 will require a separate petition reissuance and public comment period in the future.

A final decision to approve or deny the reissuance for WDW-319 will be made after the close of the comment period, which ends at the close of business on December 18, 2000. All persons, including the applicant, who wish to comment on the proposed decision to reissue the exemption may do so by submitting comments along with their name, address, phone number, and fax number (if available) to the EPA address shown below. All written comments must be postmarked by December 18, 2000, to be considered in formulating a final decision.

A public hearing is scheduled at 6:30 p.m. on Thursday, November 30, 2000, in the Wheeler Auditorium (A-1034) at the San Jacinto College North, 5800 Uvalde Street, Houston, Texas. Anyone needing special provisions at the hearing site due to disabilities (i.e., interpreters for the hearing impaired, wheelchair access, etc.), is requested to contact the EPA, within ten (10) working days of the hearing date, at the EPA address below or at the following e-mail address: howard.minnie@epa.gov.

Written comments, requests for information regarding the Agency's decision on this reissuance, and requests for copies of the fact sheet (description of the reasons supporting the proposed decision) should be sent to EPA Region 6 at the address shown below. Information on the Agency's decision may also be obtained by contacting Ms. Minnie Howard at (214) 665-7189 or howard.minnie@epa.gov.

U.S. Environmental Protection Agency - Region 6
Source Water Protection Branch (6WQ-SG)
1445 Ross Avenue
Dallas, Texas 75202-2733

The administrative record for this proposed reissuance decision is available for review beginning October 30, 2000, between 8:00 a.m. and 4:00 p.m., Monday through Friday, for the extent of the comment period at EPA's Dallas office shown above. A copy of the initial petition and reissuance documentation is also available for review during normal business hours at the following location:

Harris County Public Library
North Channel Branch
15741 Wallisville Road
Houston, Texas 77049
(281) 457-1631

Pertinent EPA comment and public hearing procedures may be found in 40 C.F.R. §124.10 and §124.12.

The EPA will notify the applicant and each person who has submitted written comments of the final reissuance decision. The final decision will also be published in the Federal Register.

October 26, 2000

FACT SHEET

EPA is proposing to approve a reissuance of an exemption to the land disposal restrictions for the following injection well facility:

Applicant: MERISOL USA LLC
Greens Bayou Plant
1914 Haden Road
Houston, TX 77015

Permit Number: WDW-319

Issuing Office: U.S. Environmental Protection Agency
Region 6
Fountain Place
1445 Ross Avenue
Dallas, TX 75202-2733

Decision

The Environmental Protection Agency (EPA) proposes to approve the MERISOL USA LLC (Merisol) reissuance request to add the newly drilled injection well, WDW-319, for injection into the Frio sands. This approval will also terminate the use of the existing well, WDW-147. The following is an explanation of the derivation of the proposed decision, which is categorized according to the criteria outlined in 40 CFR Part 148. [53 Fed. Reg., 28118, (7/26/88)]

Summary

The EPA land disposal restrictions promulgated under Section 3004 of the Resource Conservation and Recovery Act prohibit the injection of hazardous waste unless a petitioner demonstrates to the EPA that there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous. These no migration demonstrations must meet the regulatory standards promulgated in 40 CFR 148 Subpart C. Merisol successfully demonstrated no migration for injection into the Frio sands for injection well WDW-147 at the Greens Bayou plant effective December 2, 1994. Merisol received approval for nonsubstantive revisions on September 3, 1997, for a name change from Merichem Company to Merichem-Sasol USA LLC and on August 16, 2000, for a name change from Merichem-Sasol USA LLC to MERISOL USA LLC.

At the time the petition demonstration was prepared, WDW-319 was not drilled. However, Merisol included the injection into the proposed WDW-319 in the modeling demonstration. The original well, WDW-147, injects into the Frio E-F sands. The new well, WDW-319, was modeled for injection into the Frio E-F, Frio A-B, and Frio C sands. Well WDW-319 was drilled and is

currently completed into the Frio A-B and Frio C sands. The regulations contained in 40 CFR §148.20(e) allow for reissuance of an approved petition if the reissuance also meets the no migration criteria. Merisol demonstrated that the addition of injection well WDW-319 complies with the requirements of 40 CFR Part 148.

Additionally, the last mechanical integrity test for the existing injection well, WDW-147, was conducted on September 29, 1999. According to 40 CFR §148.20(a)(2)(iv), the pressure test and radioactive tracer tests must be performed within one year prior to submission of the petition demonstrating the mechanical integrity of the well. Since the most current mechanical integrity test available for WDW-147 does not meet this requirement, this proposal will terminate the use of the existing well WDW-147. Merisol may request approval for WDW-147 by demonstrating the well has passed mechanical integrity. Any proposed decision for WDW-147 will require a separate petition reissuance and public comment period in the future.

The factors considered in the formulation of this proposed petition decision are described below.

Hydrogeology

According to 40 CFR §148.20(a), a petitioner must submit hydrogeologic information in order to study the effects of the injection well activity. Merisol provided hydrogeologic information in the petition which demonstrates that USDWs (Underground Sources of Drinking Water) are properly protected. The base of the lowermost USDW is at approximately 3070' feet below mean sea level at the facility.

Artificial Penetrations

The petition applicant submitted information on all artificial penetrations (wells) which penetrate the injection or confining zones within the area of review (area within a 2 mile radius of the injection well - 40 CFR §146.63) and the 10,000 year waste plume boundary. This information was updated since the initial demonstration was approved in 1994. All of these wells were evaluated and are plugged or constructed so that any waste migration due to pressure or molecular diffusion in an artificial penetration would remain within the injection zone. [40 CFR §§148.20(a)(1) & (2)(i)-(iii)]

Mechanical Integrity Testing (MIT) Information

To assure that the wastes will reach the injection interval, a petitioner must submit the results of pressure and radioactive tracer tests according to 40 CFR §148.20(a)(2)(iv). These tests demonstrate mechanical integrity of a well's long string casing, injection tubing, annular seal, and bottom hole cement. The tests confirm that all injected fluids are entering the approved injection interval and that no fluids are channeling up the wellbore out of the injection zone. This reissuance demonstrates that the following well was tested and satisfies the above criteria:

Well Number	Pressure Test	Radioactive Tracer Survey
WDW-319	9/22/00	9/28/00

The last mechanical integrity test for the existing injection well, WDW-147, was conducted on September 29, 1999. According to 40 CFR §148.20(a)(2)(iv), the pressure test and radioactive tracer tests must be performed within one year prior to submission of the petition demonstrating the mechanical integrity of the well. Since the most current mechanical integrity test available for WDW-147 does not meet this requirement, this proposal will terminate the use of this well.

Regional and Local Geology

Class I hazardous waste injection wells must be located in areas that are geologically suitable. The injection zone must have sufficient permeability, porosity, thickness, and areal extent to prevent migration of fluids into USDWs. The confining zone must be laterally continuous and free of transmissive faults or fractures to prevent the movement of fluids into a USDW and must contain at least one formation capable of preventing vertical propagation of fractures. The Merisol facility is sited in an area meeting the above criteria.

An evaluation of the structural and stratigraphic geology of the local and regional area determined that the Merisol facility is located at a geologically suitable site. The injection zone is of sufficient permeability, porosity, thickness, and areal extent to meet requirements stated in 40 CFR Part 148. The confining zone is laterally continuous and free of transecting, transmissive faults or fractures over an area sufficient to prevent the movement of fluids into a USDW.

The geologic conditions for the Merisol site were presented through a discussion of the depositional environments, well logs, cross-sections, well tests, and geologic maps. The geologic cross-sections demonstrated the lateral relationships of the injection and confining zones. This justified some of the modeling assumptions. Well falloff tests support the injection zone permeability values in the modeling strategies.

The depths to the geologic zones are as follows:

WDW-319

Confining Zone:	4758 - 5134 feet
Injection Zone:	5134 - 7410 feet
Injection Intervals:	6580 - 6795 feet - Frio E-F
	6830 - 6984 feet - Frio A-B
	7100 - 7290 feet - Frio C

(All depths are referenced to WDW-319 Baker Atlas Induction Log dated August 31, 2000)

Modeling Strategy

According to 40 CFR §148.21(a)(3), in demonstrating no migration of hazardous constituents from the injection zone, predictive models shall have been verified and validated, shall be appropriate for the specific site and waste streams, and shall be calibrated for existing sites. The modeling strategy consisted of a combination of numerical and analytical models. All the models used were identified as being verified and validated according to the information submitted in the petition. This information consisted of actual model documentation or references of methods or

techniques that are widely accepted by the technical community. The petition reissuance describes the predictive models used and demonstrates that the above criteria are met.

According to 40 CFR §148.21(a)(5), reasonably conservative values shall be used whenever values taken from the literature or estimated on the basis of known information are used instead of site-specific measurements. Many variables were required to be quantified in order to employ the models used in the petition. All parameters were conservatively assigned to produce worst case conditions for either pressure buildup or waste movement.

According to 40 CFR §148.21(a)(6), a petitioner must perform a sensitivity analysis in order to determine the effect of uncertainties associated with model parameters. Merisol provided this sensitivity analysis in its petition. Through conservative model parameter assignments within this analysis, worst case scenarios for pressure buildup and waste movement were investigated and reported.

Merisol incorporated two timeframes to complete the modeling demonstration. The operational period was modeled to demonstrate the maximum pressure buildup while the 10,000 year post injection period was modeled to predict maximum molecular diffusion and horizontal drift of the waste plumes. The operational period included historical injection and future injection projected using the maximum injection volume from the end of historical injection through 2010.

Merisol reviewed site specific data acquired during the drilling of WDW-147, annual welltests and mechanical integrity tests, and applicable literature to select the values used in the no migration demonstrations. Core data and falloff tests from other area injection wells were also evaluated and considered in the selection of modeling parameters for the Frio A-B and Frio C sands. Appropriate net thicknesses were utilized in both the pressure buildup and plume migration demonstrations. A range was assigned to some parameters to maximize their impact on the demonstration. For example, a higher permeability was assigned to maximize the lateral waste plume movement while a lower permeability was assigned to maximize the predicted pressure buildup from injection operations. The specific data acquired during the drilling of WDW-319 has been reviewed and shown to be consistent with the previous no migration demonstrations.

The pressure buildup demonstration also included the effects of area faulting and offset injection wells to maximize pressure buildup effects. The 10,000 year low density lateral plume model assumed no background gradient to maximize waste plume movement in the updip direction. A vertical diffusion demonstration was included in the petition reissuance that calculated the maximum vertical movement into intact strata and a mud-filled wellbore. The 10,000 year models demonstrated that the injected waste will not migrate vertically upward out of the injection zone or laterally within the injection zones to a point of discharge or interface with a USDW.

Quality Assurance

According to 40 CFR §148.21(a)(4), the Merisol petition must demonstrate that proper quality assurance and quality control plans were followed in preparing the petition demonstrations.

Specifically, Merisol followed appropriate protocol in identifying and locating records for artificial penetrations within the area of review (AOR). Information regarding the geology, waste characterization [40 CFR §148.21(a)(1)], hydrogeology, reservoir modeling, and well construction has also been adequately verified or bounded by worst-case scenarios.

Geochemistry and Injected Waste Compatibility

According to 40 CFR §148.21(b)(5), a petitioner must describe the geochemical conditions of the well site. The physical and chemical characteristics of the injection zone and the formation fluids in the injection zone were described in the petition. This description included a discussion of the compatibility of the injected waste with the injection zone. Merisol also provided evaluations which demonstrated that the waste stream would not adversely alter the confining capabilities of the injection and confining zones.

Characteristics of Injected Fluids

According to 40 CFR §148.22(a), the characteristics of the injection waste stream must be adequately described. These characteristics are described in the initial petition and petition reissuance and the descriptions are adequate and complete.

Results

1. Operational Life
   End of Operational Life: December 31, 2010
   Maximum Pressure Buildup:
   - Frio E and F: 195 psi
   - Frio A and B: 312 psi
   - Frio C: 514 psi

2. 10,000 Year Post-Injection Period:
   Background Gradient: 0 ft/yr and 1.6 ft/yr
   Waste Density Effects Considered: Yes
   Movement Due to Hydrocarbon Production: No
   Waste Concentration Reduction Factor: $1x10^{-8}$.
   Maximum Lateral Waste Movement:
   - Regional Drift:
     Approximately 26,800 ft, 5.3 miles in southeast direction from the plant
   - Density Differences in the Heavy Plume:
     Approximately 53,500 ft, 10 miles south of the plant (downdip). Model reached a structural low in approximately 3000 years and the plume was structurally contained from that point in time.
   - Density Difference in the Light Plume:
     Approximately 17,600 ft, 3.3 miles in a northwest direction from the plant (updip)

   Maximum Vertical Waste Movement: Approximately 163 feet through shale and 518 feet in a mud filled borehole.

Proposed Petition Approval Conditions

The proposed approval to allow injection of restricted hazardous wastes is subject to the following conditions, which are necessary to assure that the standard in 40 CFR §148.20(a) is met. The petition approval conditions were revised to reflect the changes represented by this reissuance of the initial petition. Changes in the petition conditions are identified by the underlined portions of the following conditions. All references to WDW-147 have been deleted since this proposed decision will also terminate the use of this well. Noncompliance with any of these conditions is grounds for termination of the exemption in accordance with 40 CFR §148.24(a)(1).

This proposed exemption reissuance is for well WDW-319. The no-migration demonstrations have shown that there will not be migration of injected wastes out of the injection zone for 10,000 years.

1. Injection of restricted waste shall be limited to the following injection interval and injection zone:

WDW-319	
Injection Zone:	5134 - 7410 feet
Injection Intervals:	6580 - 6795 feet - Frio E-F
	6830 - 6984 feet - Frio A-B
	7100 - 7290 feet - Frio C

(All depths are referenced to WDW-319 Baker Atlas Induction Log dated August 31, 2000)

2. The monthly average flow rate shall not exceed the following value:

Well	Monthly Average Flow Rate
WDW-319	400 gpm

3. The facility shall cease injection by December 31, 2010.

4. The characteristics of the injected waste stream shall at all times conform to those of Sections 1.1; 2.4, 3.4 and 4.3 in the petition. The density of the waste stream shall remain within a range of from 1.060 to 1.246 g/cm^3 inclusive, at 68°F (1.040 - 1.223 g/cm^3 at 150°F).

5. The proposed approval for injection is limited to the following hazardous wastes:

D002	D024	U018	U052	U101	U196
D003	D025	U019	U063	U120	U220
D018	D026	U022	U070	U137	U239
D021	D038	U037	U071	U165	F002
D023	U012	U050	U072	U188	F005

and F039 (For the constituents listed in Section 1.1 and Table 3-4 of the 1994 petition for F039 and Table 1-2 of the 2000 petition reissuance).

6. The facility must petition for approval to inject additional hazardous wastes which are not included in Condition No. 5, above. The facility must also petition for approval to increase the concentration of any waste which would necessitate the recalculation of the limiting concentration reduction factor and the extent of the waste plume. Petition modifications and reissuance should be made pursuant to §148.20 (e) or (f).

7. Merisol shall annually submit to EPA the results of a bottom hole pressure survey for WDW-319. This survey shall have been performed after shutting in the well for a period of time sufficient to allow the pressure in the injection interval to reach equilibrium, in accordance with §146.68(e)(1). This annual report should include a comparison of reservoir parameters determined from the falloff test with parameters used in the approved no migration petition.

8. Upon the expiration, cancellation, reissuance, or modification of the Texas Natural Resource Conservation Commission's Underground Injection Control permit for Well No. WDW-319, this exemption is subject to review. A new demonstration may be required if information shows that the basis for granting the exemption is no longer valid under 40 CFR §148.23 and §148.24.

In addition to the above conditions, this proposed petition reissuance approval is contingent on the validity of the information submitted in the Merisol petition reissuance request for an exemption to the land disposal restrictions. This approval is subject to termination when any of the conditions occur which are listed in 40 CFR §148.24, including noncompliance, misrepresentation of relevant facts, or a determination that new information shows that the basis for approval is no longer valid.

APPENDIX 1-2
NON SUBSTANTIVE REVISION REQUEST
NOVEMBER 18, 2003

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

November 18, 2003

CERTIFIED MAIL 7000 0520 0022 2558 3137 RETURN RECEIPT REQUESTED

Mr. Mark Garza
Manager Environmental
MERISOL USA LLC
1914 Haden Road
Houston, TX 77015-6498

Re: Merisol USA LLC October 17, 2003, Nonsubstantive Revision Request

Dear Mr. Garza:

EPA reviewed the Merisol USA LLC (Merisol) October 17, 2003, request for a nonsubstantive revision to Petition Approval Condition No. 4 of the December 27, 2000, no migration exemption. Petition Approval Condition No. 4 restricted Merisol to an instantaneous density range of 1.060 to 1.246 g/cm^3 inclusive at 68 °F. Mersiol requested Petition Approval Condition No. 4 restrict the waste stream on a narrower average specific gravity range.

Changing the current density range of 1.060 g/cm^3 - 1.246 g/cm^3 at 68 °F to an equivalent specific gravity range of 1.062 - 1.248 measured at 68 °F would simplify compliance. Specific gravity measurements are consistent with current laboratory measuring procedures used by Merisol. Conversion from specific gravity to density would no longer be required eliminating the potential of computational errors. Merisol also requested a reduction in the high-end of specific gravity range from 1.248 to 1.200 to remain within the limits of the hydrometers used to measure the specific gravity of the waste. The narrower specific gravity range of 1.062 - 1.200 referenced at 68 °F will not change the previously approved demonstration. The density in the heavy plume modeled for the December 2, 1994, exemption resulted in plume movement approximately 53,500 ft, 10 miles south of the plant (downdip). The waste plume reached a structural low in approximately 3000 years and the plume was structurally contained from that point in time. The reduction in waste specific gravity would only lengthen the time required for the waste plume to reach the structural low and would not impact the previously approved demonstration.

Merisol's request for the use of a three-whole calendar month volume weighted average specific gravity range is consistent with the July 18, 1995, letter from Myron Knudson to Mark Cheesman of the Texas Chemical Council. The sampling frequency of once per day is also consistent with Region 6 policy. This request for an average specific gravity range is within the

modeling conducted for Merisol's original 1994 no migration petition and subsequent 2000 petition reissuance for WDW-319, both available for public review. Therefore, EPA agrees that this is a nonsubstantive revision and I am approving the request to revise the December 27, 2000, Petition Approval Condition No. 4 to read as follows:

4. The characteristics of the injected waste stream shall always conform to those of Sections 1.1, 2.4, 3.4, and 4.3 of the December 2, 1994, original no migration petition document. The running three-whole calendar month volume weighted specific gravity of the waste stream shall remain within a range of 1.062 to 1.200 measured at 68 °F (20 °C). The running three-whole calendar month average shall be calculated by multiplying each day's specific gravity value by that day's injected volume, totaling those values for the previous three month period, and dividing by that three month injected volume. For the purpose of the above calculation, each day's specific gravity value shall be obtained by a representative daily grab sample.

If you have any questions, please contact Rafael Casanova at (214) 665-7165.

Sincerely yours,

Miguel I. Flores
Director
Water Quality Protection Division

cc: Ben Knape, TCEQ

APPENDIX 1-2
HWDIR APPROVAL LETTER (WDW147 & WDW319)
JUNE 28, 2006

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

June 28, 2006

CERTIFIED MAIL 7000 0520 0022 2558 3601 RETURN RECEIPT REQUESTED

Mr. Randy Shilling
SHESQ Manager
MERISOL USA LLC
1914 Haden Road
Houston, TX 77015-6498

Re: Final Injection Well No Migration Exemption Reissuance Decision

Dear Mr. Shilling:

Effective the date of this letter, the Environmental Protection Agency (EPA) approves the reissuance request for MERISOL USA LLC (MERISOL) exemption to the land disposal restrictions for the two injection wells at the Greens Bayou Plant, Houston, Texas.

The land disposal restrictions prohibit the injection of hazardous waste unless a petitioner can demonstrate to the EPA, to a reasonable degree of certainty, that there will be no migration of hazardous constituents from the injection zone for as long as the wastes remain hazardous. The land disposal restrictions for injection wells codified in 40 CFR Part 148, provide the standards and procedures by which petitions to dispose of an otherwise prohibited waste by injection will be reviewed, and by which exemptions pursuant to these petitions will be granted or denied.

A letter dated May 4, 2006, informed MERISOL that the EPA was proposing to approve MERISOL's petition reissuance request for an exemption to the land disposal restrictions. The public comment period associated with this decision began on May 8, 2006, and closed on June 22, 2006. One comment was received identifying a typographical error in the specific gravity reference temperature listed in Petition Approval Condition No. 4. The specific gravity reference temperature has been corrected to 20 °C/20 °C.

Based on a detailed technical review of the submitted petition and support documents, the EPA has determined that this information for the MERISOL facility meets the requirements of 40 CFR Part 148 by demonstrating no migration of hazardous constituents from the injection zone for 10,000 years.

The following are conditions of this exemption to the land disposal restrictions:

Petition Reissuance Approval Conditions

This final approval to allow the continued injection of restricted hazardous wastes is subject to the following conditions, which are necessary to assure that the standard in 40 CFR §148.20(a) is met. The final petition for reissuance of exemption approval conditions were revised to reflect the changes represented by this 2006 reissuance. Noncompliance with any of these conditions is grounds for termination of the exemption in accordance with 40 CFR §148.24(a)(1). This final reissued exemption is applicable to the two existing injection wells, WDW-147 and WDW-319, located at the MERISOL, Greens Bayou Plant in Houston, Texas.

1. Injection of restricted waste shall be limited to the following injection zones:

Well	Depth of Injection Zone
WDW-147	5135' - 7410' KB 8/27/78 ISF/Sonic Log
WDW-319	5134' - 7410' KB 8/31/2000 Induction Log

The injection interval shall be defined by the following correlative log depths:

Well	Injection Interval	Depth of Injection Interval
WDW-147	Frio E-F Sand	6564' - 6816' KB
	Frio A/B/C Sands	6826' - 7286' KB
	(Depths referenced to WDW-147 8/27/78 ISF/Sonic Log)	
WDW-319	Frio E-F Sand	6580' - 6821' KB
	Frio A/B/C Sands	6830' - 7290' KB
	(Depths referenced to WDW-319 8/31/2000 Induction Log)	

2. The volume injected into each injection interval during any given month shall not exceed that calculated by multiplying (injection rate, gpm)(1440 minutes/day)(number of days in that month) based on the following maximum cumulative rate limits:

Injection Interval	Maximum Cumulative Injection Rate
Frio E-F sands	750 gpm
Commingled Frio A/B/C sands	750 gpm

Additionally, the cumulative injection volume of waste with a volume weighted monthly average specific gravity less than 1.091 at 20 °C/20 °C is limited to 3.945 billion gallons. This volume will be tracked by MERISOL and reported annually to EPA Region 6.

3. The facility shall cease injection by December 31, 2020.

4. The characteristics of the injected waste stream shall at all times conform to those described in the 2000 request for petition reissuance. The specific gravity of the injected

waste shall be based on a three-whole calendar month volume weighted average specific gravity range of 1.000 to 1.200 at 20 °C/20 °C. The three-month average shall be calculated by multiplying each day's specific gravity value by that day's injected volume, totaling those values for the previous three-whole calendar month period, and dividing by that three-month injected volume. Each day's specific gravity value shall be obtained by at least one representative grab sample.

5. The final approval for injection is limited to the following hazardous wastes:

D001, D002, D003, D004, D005, D006, D007, D008, D009, D010, D011, D012, D013, D014, D015, D016, D017, D018, D019, D020, D021, D022, D023, D024, D025, D026, D027, D028, D029, D030, D031, D032, D033, D034, D035, D036, D037, D038, D039, D040, D041, D042, D043

F001, F002, F003, F004, F005, F006, F007, F008, F009, F010, F011, F012, F019, F020, F021, F022, F023, F024, F025, F026, F027, F028, F032, F034, F035, F037, F038, F039

K001, K002, K003, K004, K005, K006, K007, K008, K009, K010, K011, K013, K014, K015, K016, K017, K018, K019, K020, K021, K022, K023, K024, K025, K026, K027, K028, K029, K030, K031, K032, K033, K034, K035, K036, K037, K038, K039, K040, K041, K042, K043, K044, K045, K046, K047, K048, K049, K050, K051, K052, K060, K061, K062, K069, K071, K073, K083, K084, K085, K086, K087, K088, K093, K094, K095, K096, K097, K098, K099, K100, K101, K102, K103, K104, K105, K106, K107, K108, K109, K110, K111, K112, K113, K114, K115, K116, K117, K118, K123, K124, K125, K126, K131, K132, K136, K141, K142, K143, K144, K145, K147, K148, K149, K150, K151, K156, K157, K158, K159, K161, K169, K170, K171, K172, K174, K175, K176, K177, K178, K181

P001, P002, P003, P004, P005, P006, P007, P008, P009, P010, P011, P012, P013, P014, P015, P016, P017, P018, P020, P021, P022, P023, P024, P026, P027, P028, P029, P030, P031, P033, P034, P036, P037, P038, P039, P040, P041, P042, P043, P044, P045, P046, P047, P048, P049, P050, P051, P054, P056, P057, P058, P059, P060, P062, P063, P064, P065, P066, P067, P068, P069, P070, P071, P072, P073, P074, P075, P076, P077, P078, P081, P082, P084, P085, P087, P088, P089, P092, P093, P094, P095, P096, P097, P098, P099, P101, P102, P103, P104, P105, P106, P108, P109, P110, P111, P112, P113, P114, P115, P116, P118, P119, P120, P121, P122, P123, P127, P128, P185, P188, P189, P190, P191, P192, P194, P196, P197, P198, P199, P201, P202, P203, P204, P205

U001, U002, U003, U004, U005, U006, U007, U008, U009, U010, U011, U012, U014, U015, U016, U017, U018, U019, U020, U021, U022, U023, U024, U025, U026, U027, U028, U029, U030, U031, U032, U033, U034, U035, U036, U037, U038, U039, U041, U042, U043, U044, U045, U046, U047, U048, U049, U050, U051, U052, U053, U055, U056, U057, U058, U059, U060, U061, U062, U063, U064, U066, U067, U068, U069,

U070, U071, U072, U073, U074, U075, U076, U077, U078, U079, U080, U081, U082, U083, U084, U085, U086, U087, U088, U089, U090, U091, U092, U093, U094, U095, U096, U097, U098, U099, U101, U102, U103, U105, U106, U107, U108, U109, U110, U111, U112, U113, U114, U115, U116, U117, U118, U119, U120, U121, U122, U123, U124, U125, U126, U127, U128, U129, U130, U131, U132, U133, U134, U135, U136, U137, U138, U140, U141, U142, U143, U144, U145, U146, U147, U148, U149, U150, U151, U152, U153, U154, U155, U156, U157, U158, U159, U160, U161, U162, U163, U164, U165, U166, U167, U168, U169, U170, U171, U172, U173, U174, U176, U177, U178, U179, U180, U181, U182, U183, U184, U185, U186, U187, U188, U189, U190, U191, U192, U193, U194, U196, U197, U200, U201, U202, U203, U204, U205, U206, U207, U208, U209, U210, U211, U213, U214, U215, U216, U217, U218, U219, U220, U221, U222, U223, U225, U226, U227, U228, U234, U235, U236, U237, U238, U239, U240, U243, U244, U246, U247, U248, U249, U271, U278, U279, U280, U328, U353, U359, U364, U367, U372, U373, U387, U389, U394, U395, U404, U409, U410, U411

6. The facility must petition for approval to inject additional hazardous wastes which are not included in Condition No. 5, above. The facility must also petition for approval to increase the concentration of any waste which would necessitate the recalculation of the limiting concentration reduction factor and the extent of the waste plume. Petition reissuance and modifications should be made pursuant to §148.20 (e) or (f).

7. MERISOL shall annually submit to EPA the results of a bottom hole pressure survey for WDW-147 and WDW-319. Each survey shall be performed after shutting in the well for a period of time sufficient to allow the pressure in the injection interval to reach equilibrium, in accordance with §146.68(e)(1). The annual report should include a comparison of reservoir parameters determined from the falloff test with parameters used in the approved no migration petition.

8. Upon the expiration, cancellation, reissuance, or modification of the Texas Commission on Environmental Quality's Underground Injection Control permit for Well Nos. WDW-147 and WDW-319, this exemption is subject to review. A new demonstration may be required if information shows that the basis for granting the exemption is no longer valid under 40 CFR §148.23 and §148.24.

In addition to the above conditions, this final approval is contingent on the validity of the information submitted in the MERISOL reissuance request for an exemption to the land disposal restrictions. Any final reissuance decision is subject to termination when any of the conditions occur which are listed in 40 CFR §148.24, including noncompliance, misrepresentation of relevant facts, or a determination that new information shows that the basis for approval is no longer valid.

If you have any questions or comments, please call Philip Dellinger at (214) 665-7165.

Sincerely yours,

Miguel I. Flores
Director
Water Quality Protection Division

cc: Bob Smith, USEPA OGWDW
Ben Knape, TCEQ
Brad Genzer, TCEQ Region 14

GEOSTOCK SANDIA
ENTREPOSE

APPENDIX 1-3

SASOL CHEMICALS (USA), LLC

CURRENT TCEQ APPROVAL PERMITS

APPENDIX 1-3
CURRENT TEXAS COMMISSION ON ENVIRONMENTAL QUALITY - UNDERGROUND INJECTION CONTROL PERMITS
INJECTION WELL NO. 1 (WDW147)

Permit No. WDW147

This permit supersedes and replaces Permit No. WDW147 issued January 12, 2006.

Texas Commission on Environmental Quality

Austin, Texas

Permit to Conduct
Class I Underground Injection
Under Provisions of Texas Water Code
Chapter 27 and Texas Health and Safety
Code Chapter 361

I. Permittee

SASOL Chemicals (USA), LLC
1914 Haden Road
Houston, TX 77015

Owner

Merichem Company
5455 Old Spanish Trail
Houston, TX 77023

II. Type of Permit

Initial_____ Renewal__X__ Amended_____
Commercial__X__ Noncommercial_X__
Hazardous__X__ Nonhazardous__X__
Onsite __X__ Offsite__X__
Authorizing Disposal of Waste from Captured Facility_____
Authorizing Disposal of Waste from Off-site Facilities Owned by Owner/Operator _X_

CONTINUED on Pages 2 through 6

The permittee is authorized to conduct injection in accordance with limitations, requirements, and other conditions set forth herein. This permit is granted subject to the rules and orders of the Commission, and the laws of the State of Texas. The permit will be in effect for ten years from the date of approval or until amended or revoked by the Commission. If this permit is appealed and the permittee does not commence any action authorized by this permit during judicial review, the term will not begin until judicial review is concluded.

DATE ISSUED: May 27, 2016

For The Commission

III. Nature of Business

Chemical manufacturing plant for cresylic acids and other chemicals and commercial underground disposal of industrial process aqueous wastes.

IV. General Description and Location of Injection Activity

The disposal well is used to dispose of hazardous and nonhazardous wastes generated by the permittee's facilities and from other sources during the manufacture cresylic acids and other chemicals. The well is located 4,000 feet from the north line and 16,900 feet from the east line of the Richard & Robert Vince Survey, A-76, Latitude 29°45'35" North, Longitude 95°10'35" West, Harris County, Texas. The injection zone is within the Frio and Vicksburg Formations at the depths of 5,119 to 7,394 feet below ground level. The authorized injection interval is within the Frio Formation at the depths of 6,548 to 7,270 feet below ground level.

For purposes of compliance with U.S. Environmental Protection Agency no-migration demonstration requirements pursuant to federal Land Disposal Restrictions, the authorized injection interval is divided into two sand packages designated as "A/B/C" sand and "E/F" sands.

V. Character of the Waste Streams

A. Industrial hazardous and nonhazardous waste authorized to be injected by this permit shall consist solely of the following waste streams:

1. Waste streams generated from plant operations and generated from off-site operations at facilities owned by the owner/operator.
2. Waste streams generated from offsite operations at facilities not owned by the owner/operator which are compatible with permitted waste streams, injection zone and well materials.
3. Other associated wastes such as groundwater and rainfall contaminated by the above authorized wastes, spills of the above authorized wastes, and wash waters and solutions used in cleaning and servicing the waste disposal well system equipment which are compatible with the permitted waste streams, injection zone and well materials.
4. Waste generated during well construction or closure of WDW147 and WDW319, and associated facilities that are compatible with permitted wastes, injection zone, and well materials.

B. The injection of wastes is limited to those wastes authorized in Provision V.A. above, into the Frio and Vicksburg Formations within the injection zone between the depths of 5,119 to 7,394 feet below ground level.

C. The pH of injected waste streams shall be greater than or equal to 4.5.

D. Except when authorized by the Executive Director, the specific gravity of injected fluids shall less than or equal to 1.25 as measured at 68°F.

VI. Waste Streams Prohibited From Injection

Unless authorized by Provision V.A., the following waste streams are prohibited:

A. Wastes prohibited from injection in 40 CFR Part 148, Subpart B, are specifically prohibited from injection by this permit, unless an exemption from prohibition has been granted pursuant to 40 CFR Part 148, Subpart C, or the wastes meet or exceed the applicable treatment standards in 40 CFR Part 268, Subpart D;

B. Any by-product material as defined by Texas Health and Safety Code §401.003(3);

C. Any low-level radioactive waste as defined by Texas Health and Safety Code §401.004;

D. Any naturally occurring radioactive material (NORM) waste as defined by Texas Health and Safety Code §401.003(26); and

E. Any oil and gas NORM waste as defined by Texas Health & Safety Code §401.003(27).

VII. Operating Parameters

The well shall be operated in compliance with the requirements of 30 TAC Chapters 305, 331, and 335; the plans and specifications of the permit application; and the following conditions:

A. Surface injection pressure shall not cause pressure in the injection zone to:

1. initiate any new fractures or propagate existing fractures in the injection zone;
2. initiate new fractures or propagate existing fractures in the confining zone; or
3. cause movement of fluid out of the injection zone that may contaminate underground sources of drinking water (USDWs), and fresh water.

B. The operating surface injection pressure shall not exceed 600 psig.

C. The maximum injection rate for WDW147 and WDW319 shall not exceed 750 gallons per minute (gpm) per well, when each well is completed in a separate sand package. If both wells are completed in a common sand package, the cumulative rate of injection shall not exceed 750 gpm.

D. The volume of wastewater injected shall not exceed 33,480,000 gallons per month, or 394,200,000 gallons per year, per well, when each well is completed in a separate sand package. If both wells are completed in a common sand package, the volume of wastewater injected shall not exceed 33,480,000 gallons per month, or 394,200,000 gallons per year.

E. A positive pressure of at least 100 psig over tubing injection pressures shall be maintained in the tubing-casing annulus for the purpose of leak detection. Temporary deviations from this requirement which are a part of normal well operations are authorized but may not exceed 15 minutes in duration. For 15

minutes after the pressure differential drops below 100 psig, the permittee shall conduct troubleshooting and proceed to restore a minimum 100 psig pressure differential. If a minimum 100 psig pressure differential cannot be achieved within 15 minutes, the permittee shall notify the Texas Commission on Environmental Quality (TCEQ) and commence shut-in procedures on the well. The permittee may continue to operate the well under flow conditions that maintain a minimum 100 psig pressure differential.

F. The permittee shall notify the Executive Director at least 24 hours prior to commencing any workover which involves taking the injection well out of service. Approval by the Executive Director shall be obtained before the permittee may begin work. Notification shall be in writing and shall include plans for the proposed work. The Executive Director may grant an exception in accordance with 30 TAC §331.63(i) when immediate action is required to comply with 30 TAC §331.63(b). Completion of the well outside the approved injection interval, by perforation of casing, setting of screen, or establishment of open hole section, requires that the permitted injection interval be changed according to 30 TAC §331.62(a)(3)(B) to include the depths of all well completion. Pressure control equipment shall be installed and maintained during workovers which involve the removal of tubing.

VIII. Monitoring and Testing Requirements

A. Monitoring and testing shall be in compliance with the requirements of 30 TAC §305.125, §331.64, the plans and specifications of the permit application, and the following conditions.

B. The integrity of the long string casing, injection tubing, and annular seal shall be tested by means of an approved pressure test with a liquid or gas annually and whenever there has been a well workover. The integrity of the cement within the injection zone shall be tested by means of an approved radioactive tracer survey annually. A radioactive tracer survey may be required after workovers that have the potential to damage the cement within the injection zone.

C. The pressure buildup in the injection zone shall be monitored annually, including at a minimum, a shutdown of the well for a sufficient time to conduct a valid observation of the pressure fall-off curve.

D. A temperature log, noise log, oxygen activation log or other approved log is required at least once every five years to test for fluid movement along the entire borehole.

E. A casing inspection, casing evaluation, or other approved log shall be run whenever the owner or operator conducts a workover in which the injection string is pulled, unless the Executive Director waives this requirement due to well construction or other factors which limit the test's reliability, or based upon the satisfactory results of a casing inspection log run within the previous five years. The Executive Director may require that a casing inspection log be run every five years if there is sufficient reason to believe the integrity of the long string casing of the well may be adversely affected by naturally occurring or man-made events.

F. Injection fluids shall be tested in accordance with 30 TAC §331.64(b) and the approved waste analysis plan.

G. The pH and specific gravity of the injected waste shall be monitored continuously at a minimum frequency of at least once every 24 hours and whenever the waste stream changes.

H. Corrosion monitoring of well materials shall be conducted quarterly and in accordance with 30 TAC §331.64(g). Test materials shall be the same as those used in the wellhead, injection tubing, packer, and long string casing, and shall be continuously exposed to the waste fluids except when the well is taken out of service.

I. The permittee shall ensure that all waste analyses used for waste identification or verification and other analyses for environmental monitoring have been performed in accordance with methods specified in the current editions of EPA SW-846, ASTM or other methods accepted by the TCEQ. The permittee shall have a Quality Assurance/Quality Control program that is consistent with EPA SW-846 and the TCEQ Quality Assurance Project Plan.

IX. Record Keeping Requirements

The permittee shall keep complete and accurate records as required by 30 TAC Chapters 305, 331, and 335.

X. Financial Assurance for Well Closure

In accordance with 30 TAC Chapter 37, §305.154(a)(9), and §§331.142-144, the permittee shall secure and maintain financial assurance, in a form approved by the Executive Director, in the amount of $319,610 (cost estimate prepared July 2015 in current dollars). Adjustments to the cost estimates for plugging and abandonment in current dollars, and to financial assurance based thereon, shall be made in accordance with 30 TAC §331.143(d) and Chapter 37.

XI. Additional Requirements

A. The base of the wellhead shall be enclosed by a diked, impermeable pad or sump to protect the ground surface from spills and releases. Any liquid collected shall be disposed of in an appropriate manner.

B. Acceptance of this permit by the permittee constitutes an acknowledgment and agreement that the permittee will comply with all the terms and conditions embodied in the permit, and the rules and other orders of the Commission.

C. This permit is subject to further orders and rules of the Commission. In accordance with the procedures for amendments and orders, the Commission may incorporate into permits already granted, any condition, restriction, limitation, or provision reasonably necessary for the administration and enforcement of Texas Water Code, Chapter 27 and Texas Health and Safety Code, Chapter 361.

D. This permit does not convey any property rights of any sort, nor any exclusive privilege, and does not become a vested right in the permittee.

E. The issuance of this permit does not authorize any injury to persons or property or an invasion of other property rights, or any infringement of state or local law or regulations.

F. The following rules are incorporated as terms and conditions of this permit by reference:

1. 30 TAC Chapter 305, Consolidated Permits;
2. 30 TAC Chapter 331, Underground Injection Control; and
3. 30 TAC Chapter 335, Industrial Solid Waste and Municipal Hazardous Waste.

G. The express incorporation of the above rules as terms and conditions of this permit does not relieve the permittee of an obligation to comply with all other laws or regulations which are applicable to the activities authorized by this permit.

H. Incorporated Application Materials. This permit is based on, and the permittee shall follow, the plans and specifications contained in the Class I Underground Injection Control Application dated July 15, 2015 and revised on November 19, 2015 which are hereby approved subject to the terms of this permit and any other orders of the TCEQ.

I. All pre-injection units servicing this well must be authorized under TCEQ permit HW 50387 under 30 TAC Chapter 335 or must be exempt from the requirement for a permit under 30 TAC §335.69.

J. The Texas solid waste registration (SWR) number for this site is 30595.

APPENDIX 1-3
CURRENT TEXAS COMMISSION ON ENVIRONMENTAL QUALITY - UNDERGROUND INJECTION CONTROL PERMITS
INJECTION WELL NO. 2 (WDW319)

Permit No. WDW319

This permit supersedes and replaces Permit No. WDW319 issued January 12, 2006.

Texas Commission on Environmental Quality

Austin, Texas

Permit to Conduct
Class I Underground Injection
Under Provisions of Texas Water Code
Chapter 27 and Texas Health and Safety
Code Chapter 361

I. Permittee

SASOL Chemicals (USA), LLC
1914 Haden Road
Houston, TX 77015

Owner

Merichem Company
5455 Old Spanish Trail
Houston, TX 77023

II. Type of Permit

Initial_____ Renewal__X__ Amended_____
Commercial__X__ Noncommercial__X__
Hazardous__X__ Nonhazardous__X__
Onsite __X__ Offsite__X__
Authorizing Disposal of Waste from Captured Facility_____
Authorizing Disposal of Waste from Off-site Facilities Owned by Owner/Operator _X_

CONTINUED on Pages 2 through 6

The permittee is authorized to conduct injection in accordance with limitations, requirements, and other conditions set forth herein. This permit is granted subject to the rules and orders of the Commission, and the laws of the State of Texas. The permit will be in effect for ten years from the date of approval or until amended or revoked by the Commission. If this permit is appealed and the permittee does not commence any action authorized by this permit during judicial review, the term will not begin until judicial review is concluded.

DATE ISSUED: May 27, 2016

For The Commission

III. Nature of Business

Chemical manufacturing plant for cresylic acids and other chemicals and commercial underground disposal of industrial process aqueous wastes.

IV. General Description and Location of Injection Activity

The disposal well is used to dispose of hazardous and nonhazardous wastes generated by the permittee's facilities and from other sources during the manufacture cresylic acids and other chemicals. The well is located 4,140 feet from the north line and 17,145 feet from the east line of the Richard & Robert Vince Survey, A-76, Latitude 29°45'33.7" North, Longitude 95°10'37.9" West, Harris County, Texas. The injection zone is within the Frio and Vicksburg Formations at the depths of 5,119 to 7,394 feet below ground level. The authorized injection interval is within the Frio Formation at the depths of 6,564 to 7,274 feet below ground level.

For purposes of compliance with U.S. Environmental Protection Agency no-migration demonstration requirements pursuant to federal Land Disposal Restrictions, the authorized injection interval is divided into two sand packages designated as "A/B/C" sand and "E/F" sands.

V. Character of the Waste Streams

A. Industrial hazardous and nonhazardous waste authorized to be injected by this permit shall consist solely of the following waste streams:

1. Waste streams generated from plant operations and generated from off-site operations at facilities owned by the owner/operator.
2. Waste streams generated from offsite operations at facilities not owned by the owner/operator which are compatible with permitted waste streams, injection zone and well materials.
3. Other associated wastes such as groundwater and rainfall contaminated by the above authorized wastes, spills of the above authorized wastes, and wash waters and solutions used in cleaning and servicing the waste disposal well system equipment which are compatible with the permitted waste streams, injection zone and well materials.
4. Waste generated during well construction or closure of WDW147 and WDW319, and associated facilities that are compatible with permitted wastes, injection zone, and well materials.

B. The injection of wastes is limited to those wastes authorized in Provision V.A. above, into the Frio and Vicksburg Formations within the injection zone between the depths of 5,119 to 7,394 feet below ground level.

C. The pH of injected waste streams shall be greater than or equal to 4.5.

D. Except when authorized by the Executive Director, the specific gravity of injected fluids shall less than or equal to 1.25 as measured at 68°F.

VI. Waste Streams Prohibited From Injection

Unless authorized by Provision V.A., the following waste streams are prohibited:

A. Wastes prohibited from injection in 40 CFR Part 148, Subpart B, are specifically prohibited from injection by this permit, unless an exemption from prohibition has been granted pursuant to 40 CFR Part 148, Subpart C, or the wastes meet or exceed the applicable treatment standards in 40 CFR Part 268, Subpart D;

B. Any by-product material as defined by Texas Health and Safety Code §401.003(3);

C. Any low-level radioactive waste as defined by Texas Health and Safety Code §401.004;

D. Any naturally occurring radioactive material (NORM) waste as defined by Texas Health and Safety Code §401.003(26); and

E. Any oil and gas NORM waste as defined by Texas Health & Safety Code §401.003(27).

VII. Operating Parameters

The well shall be operated in compliance with the requirements of 30 TAC Chapters 305, 331, and 335; the plans and specifications of the permit application; and the following conditions:

A. Surface injection pressure shall not cause pressure in the injection zone to:

1. initiate any new fractures or propagate existing fractures in the injection zone;
2. initiate new fractures or propagate existing fractures in the confining zone; or
3. cause movement of fluid out of the injection zone that may contaminate underground sources of drinking water (USDWs), and fresh water.

B. The operating surface injection pressure shall not exceed 1,200 psig.

C. The maximum injection rate for WDW147 and WDW319 shall not exceed 750 gallons per minute (gpm) per well, when each well is completed in a separate sand package. If both wells are completed in a common sand package, the cumulative rate of injection shall not exceed 750 gpm.

D. The volume of wastewater injected shall not exceed 33,480,000 gallons per month, or 394,200,000 gallons per year, per well, when each well is completed in a separate sand package. If both wells are completed in a common sand package, the volume of wastewater injected shall not exceed 33,480,000 gallons per month, or 394,200,000 gallons per year.

E. A positive pressure of at least 100 psig over tubing injection pressures shall be maintained in the tubing-casing annulus for the purpose of leak detection.

Temporary deviations from this requirement which are a part of normal well operations are authorized but may not exceed 15 minutes in duration. For 15 minutes after the pressure differential drops below 100 psig, the permittee shall

conduct troubleshooting and proceed to restore a minimum 100 psig pressure differential. If a minimum 100 psig pressure differential cannot be achieved within 15 minutes, the permittee shall notify the Texas Commission on Environmental Quality (TCEQ) and commence shut-in procedures on the well. The permittee may continue to operate the well under flow conditions that maintain a minimum 100 psig pressure differential.

F. The permittee shall notify the Executive Director at least 24 hours prior to commencing any workover which involves taking the injection well out of service. Approval by the Executive Director shall be obtained before the permittee may begin work. Notification shall be in writing and shall include plans for the proposed work. The Executive Director may grant an exception in accordance with 30 TAC §331.63(i) when immediate action is required to comply with 30 TAC §331.63(b). Completion of the well outside the approved injection interval, by perforation of casing, setting of screen, or establishment of open hole section, requires that the permitted injection interval be changed according to 30 TAC §331.62(a)(3)(B) to include the depths of all well completion. Pressure control equipment shall be installed and maintained during workovers which involve the removal of tubing.

VIII. Monitoring and Testing Requirements

A. Monitoring and testing shall be in compliance with the requirements of 30 TAC §305.125, §331.64, the plans and specifications of the permit application, and the following conditions.

B. The integrity of the long string casing, injection tubing, and annular seal shall be tested by means of an approved pressure test with a liquid or gas annually and whenever there has been a well workover. The integrity of the cement within the injection zone shall be tested by means of an approved radioactive tracer survey annually. A radioactive tracer survey may be required after workovers that have the potential to damage the cement within the injection zone.

C. The pressure buildup in the injection zone shall be monitored annually, including at a minimum, a shutdown of the well for a sufficient time to conduct a valid observation of the pressure fall-off curve.

D. A temperature log, noise log, oxygen activation log or other approved log is required at least once every five years to test for fluid movement along the entire borehole.

E. A casing inspection, casing evaluation, or other approved log shall be run whenever the owner or operator conducts a workover in which the injection string is pulled, unless the Executive Director waives this requirement due to well construction or other factors which limit the test's reliability, or based upon the satisfactory results of a casing inspection log run within the previous five years. The Executive Director may require that a casing inspection log be run every five years if there is sufficient

reason to believe the integrity of the long string casing of the well may be adversely affected by naturally occurring or man-made events.

F. Injection fluids shall be tested in accordance with 30 TAC §331.64(b) and the approved waste analysis plan.

G. The pH and specific gravity of the injected waste shall be monitored continuously at a minimum frequency of at least once every 24 hours and whenever the waste stream changes.

H. Corrosion monitoring of well materials shall be conducted quarterly and in accordance with 30 TAC §331.64(g). Test materials shall be the same as those used in the wellhead, injection tubing, packer, and long string casing, and shall be continuously exposed to the waste fluids except when the well is taken out of service.

I. The permittee shall ensure that all waste analyses used for waste identification or verification and other analyses for environmental monitoring have been performed in accordance with methods specified in the current editions of EPA SW-846, ASTM or other methods accepted by the TCEQ. The permittee shall have a Quality Assurance/Quality Control program that is consistent with EPA SW-846 and the TCEQ Quality Assurance Project Plan.

IX. Record Keeping Requirements

The permittee shall keep complete and accurate records as required by 30 TAC Chapters 305, 331, and 335.

X. Financial Assurance for Well Closure

In accordance with 30 TAC Chapter 37, §305.154(a)(9), and §§331.142-144, the permittee shall secure and maintain financial assurance, in a form approved by the Executive Director, in the amount of $319,610 (cost estimate prepared July 2015 in current dollars). Adjustments to the cost estimates for plugging and abandonment in current dollars, and to financial assurance based thereon, shall be made in accordance with 30 TAC §331.143(d) and Chapter 37.

XI. Additional Requirements

A. The base of the wellhead shall be enclosed by a diked, impermeable pad or sump to protect the ground surface from spills and releases. Any liquid collected shall be disposed of in an appropriate manner.

B. Acceptance of this permit by the permittee constitutes an acknowledgment and agreement that the permittee will comply with all the terms and conditions embodied in the permit, and the rules and other orders of the Commission.

C. This permit is subject to further orders and rules of the Commission. In accordance with the procedures for amendments and orders, the Commission may incorporate into permits already granted, any condition, restriction, limitation, or provision reasonably necessary for the administration and enforcement of Texas Water Code, Chapter 27 and Texas Health and Safety Code, Chapter 361.

D. This permit does not convey any property rights of any sort, nor any exclusive privilege, and does not become a vested right in the permittee.

E. The issuance of this permit does not authorize any injury to persons or property or an invasion of other property rights, or any infringement of state or local law or regulations.

F. The following rules are incorporated as terms and conditions of this permit by reference:

1. 30 TAC Chapter 305, Consolidated Permits;
2. 30 TAC Chapter 331, Underground Injection Control; and
3. 30 TAC Chapter 335, Industrial Solid Waste and Municipal Hazardous Waste.

G. The express incorporation of the above rules as terms and conditions of this permit does not relieve the permittee of an obligation to comply with all other laws or regulations which are applicable to the activities authorized by this permit.

H. Incorporated Application Materials. This permit is based on, and the permittee shall follow, the plans and specifications contained in the Class I Underground Injection Control Application dated July 15, 2015 and revised on November 19, 2015 which are hereby approved subject to the terms of this permit and any other orders of the TCEQ.

I. All pre-injection units servicing this well must be authorized under TCEQ permit HW 50387 under 30 TAC Chapter 335 or must be exempt from the requirement for a permit under 30 TAC §335.69.

J. The Texas solid waste registration (SWR) number for this site is 30595.

APPENDIX 1-4

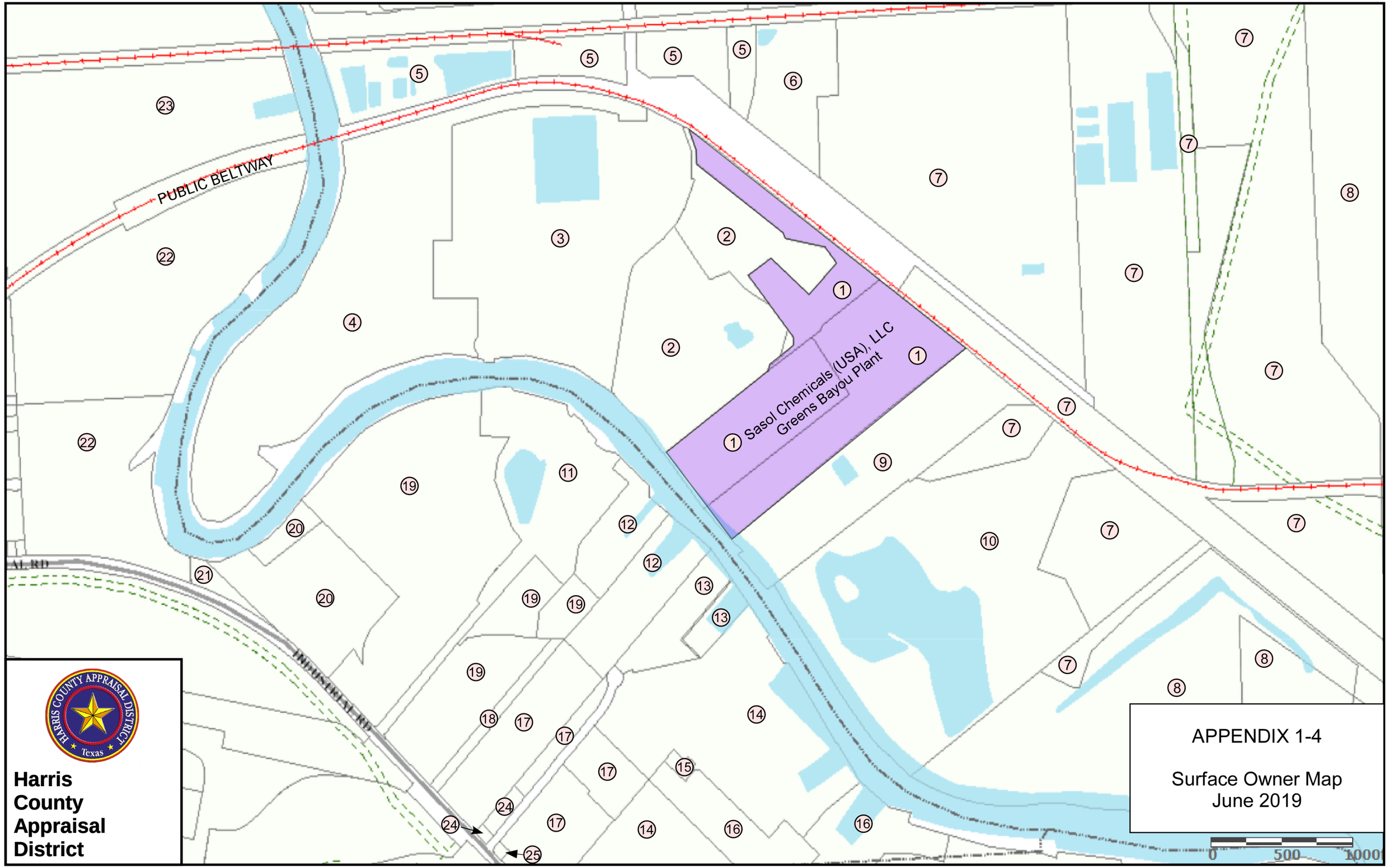
LAND AND MINERAL OWNER INFORMATION

LAND OWNER INFORMATION

APPENDIX 1-4 ADJACENT LAND OWNERS			
Number Key	Owner	Number Key	Owner
1.	Merisol USA, LLC 1914 Haden Road Houston, TX 77015-6408	9.	Arkema Inc. 2000 Market St FL 27 Philadelphia, PA 19103-7006
2.	Merichem Co. 5455 Old Spanish Trail Houston, TX 77023-5013	10.	ISK Magnetics % ISK Americas 7474 Auburn Rd Painsville, OH 44077-9703
3.	Brenntag Southwest Inc. 1632 Haden Rd. Houston, TX 77015-6402	11.	Channel Biorefinery & Terminals LLC 13605 Industrial Rd. Houston, TX 77015-6818
4.	Haden Road Corp. 1100 Louisiana St, Ste 3160 Houston, TX 77002-5218	12.	Trinity Industries Inc. DBA Platzer Shipyard 2525 N. Stemmos Fwy Dallas, TX 75207-2401
5.	Reichhold LLC 2 PO Box 13582 Durham, NC 27709-3582	13.	Platzer Shipyard 2525 N. Stemmos Fwy Dallas, TX 75207-2401
6.	PVS Technologies Inc. 10900 Harper Ave Detroit, MI 48213-3364	14.	LEX Houston II LP 1 Penn Plz Ste 4015 New York, NY 10119-4015
7.	GB Biosciences Corp. PO Box 18300 Greensboro, NC 27419-8300	15.	Nerro Supply LLC PO Box 691008 Houston, TX 77269-1008
8.	Port of Houston Authority 111 East Loop N Houston, TX 77029	16.	Greens bayou Holding LTD. PO Box 9940 Houston, TX 77213-0940

17.	SMRK Holdings LLC. PO Box 8744 Houston, TX 77249-8744	22.	Glenn E. Seureau 3214 Inwood Dr. Houston, TX 77019-3228
18.	Parker Brothers & Co Inc. PO Box 107 Houston, TX 77001-0107	23.	Womble Co. Inc. Larry McKinney 12821 Industrial Rd. Houston, TX 77015-6802
19.	Womble Company Inc. 12821 Industrial Rd Houston, TX 77015-6802	24.	Centerpoint Energy Houston Electric Property Tax Dept. 38th FLR PO Box 1475 Houston, TX 77251-1475
20.	Densimic Holding Corp 15311 Vantage Pkwy W Ste. 350 Houston, TX 77032-1988	25.	Crown Castle GT Comp LLC % Tax Department KT3595 4017 Washington Rd. PMB 353 Canonsburg, PA 15317-2520
21.	Southern Tube LLC 13500 Industrial Rd. Houston, TX 77015-6817		

The surrounding land usage is predominately industrial and commerial. No residential properties are adjacenet to the Greens Bayou Plant.


PUBLIC BELTWAY
INDUSTRIAL RD
1 Sasol Chemicals (USA), LLC
Greens Bayou Plant
APPENDIX 1-4
Surface Owner Map
June 2019
0
500
1000
Harris County Appraisal District
GEOSTOCK SANDIA
ENTREPOSE

MINERAL OWNER INFORMATION

APPENDIX 1-4 MINERAL RIGHTS OWNERS	
Tract No.	Owner
1.	Merisol USA, LLC 1914 Haden Road Houston, TX 77015-6408
2.	Merisol USA, LLC 1914 Haden Road Houston, TX 77015-6408
3.	Merisol USA, LLC 1914 Haden Road Houston, TX 77015-6408
	Sylvan S. Khan Estate P.O. Box 218587 Houston, TX 77218
4.	Merisol USA, LLC 1914 Haden Road Houston, TX 77015-6408
5.	Merisol USA, LLC 1914 Haden Road Houston, TX 77015-6408
6.	Merichem Co. 5455 Old Spanish Trail Houston, TX 77023-5013
7.	Merichem Co. 5455 Old Spanish Trail Houston, TX 77023-5013
8.	Merichem Co. 5455 Old Spanish Trail Houston, TX 77023-5013

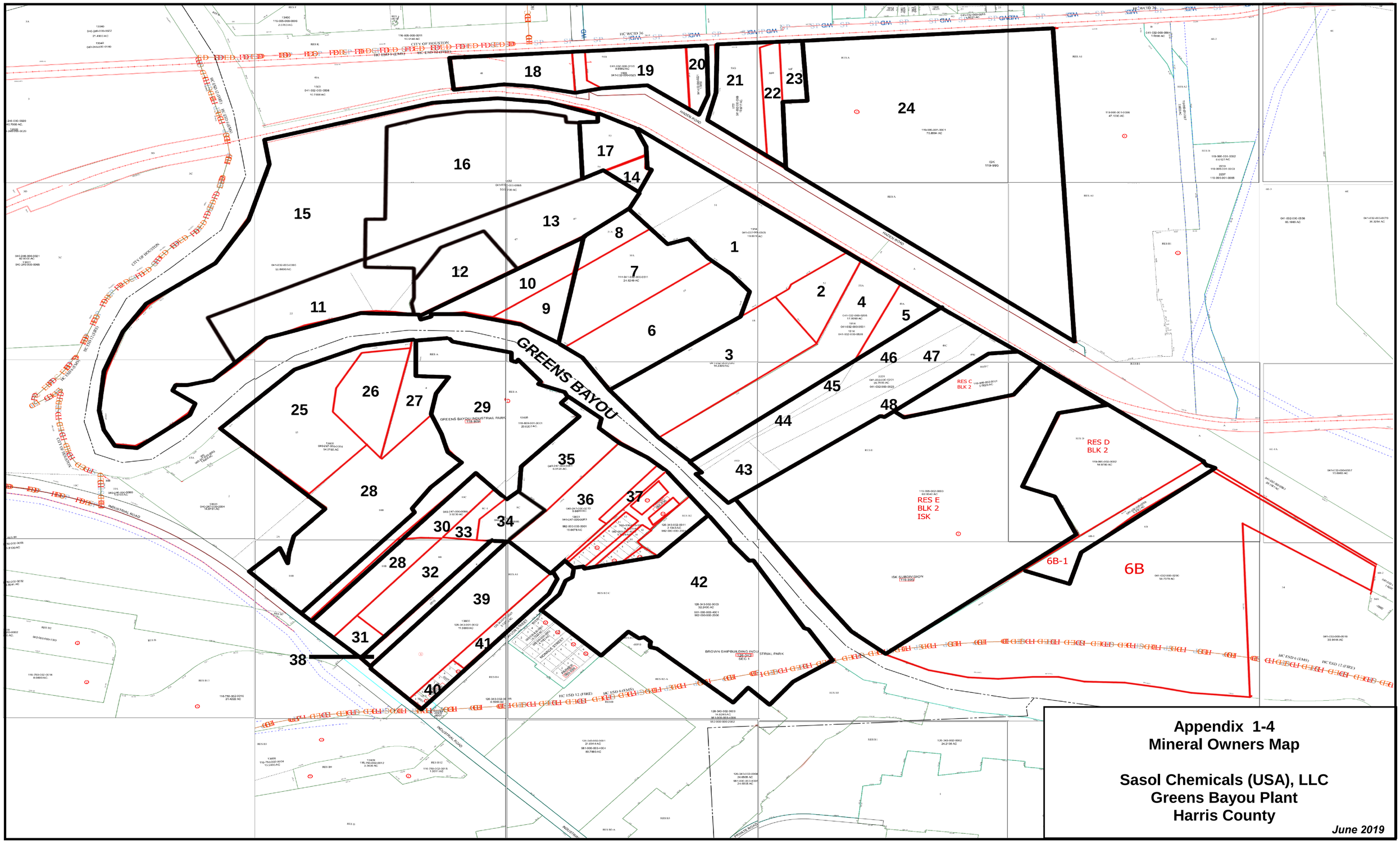
APPENDIX 1-4 MINERAL RIGHTS OWNERS	
Tract No.	Owner
9.	Altivia Corp. 1100 Louisiana St. Ste 3160 Houston, TX 77002-5218
10.	Altivia Corp. 1100 Louisiana St. Ste 3160 Houston, TX 77002-5218
11.	Estate of Fannie Booty Brooks. Deceased prior to 1950. No record of probate was located in Harris County, Texas for Fannie Brooks or history of mineral rights prior to 1934.
12.	Estate of Fannie Booty Brooks. Deceased prior to 1950. No record of probate was located in Harris County, Texas for Fannie Brooks or history of mineral rights prior to 1934.
13.	Estate of Fannie Booty Brooks. Deceased prior to 1950. No record of probate was located in Harris County, Texas for Fannie Brooks or history of mineral rights prior to 1934.
14.	Altivia Corp. 1100 Louisiana St. Ste 3160 Houston, TX 77002-5218
15.	Estate of Fannie Booty Brooks. Deceased prior to 1950. No record of probate was located in Harris County, Texas for Fannie Brooks or history of mineral rights prior to 1934.
16.	Altivia Corp. 1100 Louisiana St. Ste 3160 Houston, TX 77002-5218
17.	Altivia Corp. 1100 Louisiana St. Ste 3160 Houston, TX 77002-5218
18.	Reichhold Inc. % Tommy Riley P.O. Box 13582 Durham, NC 27709-3582

APPENDIX 1-4 MINERAL RIGHTS OWNERS	
Tract No.	Owner
19.	Reichhold Inc. % Tommy Riley P.O. Box 13582 Durham, NC 27709-3582
20.	Reichhold Inc. % Tommy Riley P.O. Box 13582 Durham, NC 27709-3582
21.	PVS Technologies Inc. 10900 Harper Ave Detroit, MI 48213-3364
22.	JCI Jones Chemicals, Inc. 1765 Ringling Blvd. Sarasota, FL 34236
23.	JCI Jones Chemicals, Inc. 1765 Ringling Blvd. Sarasota, FL 34236
24.	G B Biosciences Corp. 2239 Haden Rd Houston, TX 77015-6449
25.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
26.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
27.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802

APPENDIX 1-4 MINERAL RIGHTS OWNERS	
Tract No.	Owner
28.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
29.	Channel Bio Refinery & Terminals LLC 13605 Insdustrial Rd Houston, TX 77015-6818
30.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
31.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
32.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
33.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
34.	Womble Co. Inc. 12821 Industrial Rd. Houston, TX 77015-6802
35.	Trinity Industries Inc. DBA Platzer Shipyard 2525 N. Stemmons Fwy Dallas, TX 75207-2401

APPENDIX 1-4 MINERAL RIGHTS OWNERS	
Tract No.	Owner
36.	Trinity Industries Inc. DBA Platzer Shipyard 2525 N. Stemmons Fwy Dallas, TX 75207-2401
37.	Trinity Industries Inc. DBA Platzer Shipyard 2525 N. Stemmons Fwy Dallas, TX 75207-2401
38.	Parker Brothers & Co. Inc. P.O. Box 107 Houston, TX 77001-0107
39.	SMRK Holdings LLC P.O. Box 8744 Houston, TX 77249-8744
40.	SMRK Holdings LLC P.O. Box 8744 Houston, TX 77249-8744
41.	SMRK Holdings LLC P.O. Box 8744 Houston, TX 77249-8744
42.	Deck Building Partners LP P.O. Box 3417 Little Rock, AR 72203-3417
43.	Arkema Inc. 2000 Market St. Philidelphia, PA 19103-7006

APPENDIX 1-4 MINERAL RIGHTS OWNERS	
Tract No.	Owner
44.	Arkema Inc. 2000 Market St. Philidelphia, PA 19103-7006
45.	Arkema Inc. 2000 Market St. Philidelphia, PA 19103-7006
46.	Arkema Inc. 2000 Market St. Philidelphia, PA 19103-7006
47.	Arkema Inc. 2000 Market St. Philidelphia, PA 19103-7006
48.	Arkema Inc. 2000 Market St. Philidelphia, PA 19103-7006
Greens Bayou	State of Texas General Land Office Deputy Commissioner of Asset Aquistion Steven F. Austin Building 1700 North Congress Austin, Texas 78701



Appendix 1-4
Mineral Owners Map

Sasol Chemicals (USA), LLC
Greens Bayou Plant
Harris County

June 2019